FINAL REPORT

ON A

PARACHUTE RECOVERY SYSTEM

FOR A

RECORDER CAPSULE

REPORT: NO. 8 (FEBRUARY 7, 1966)

PREPARED BY: SPACE CORP.
DALLAS, TEXAS

JOB NO: 2101

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ABSTRACT.

This report concludes all work to be performed under subject contract for the period January 14, 1966 through February 7, 1966, and fulfills the requirement of Article I, Paragraph C, Sub-Paragraph 2, of the Scope of Work attachment to the contract, wherein this report documents and summarizes the results of work performed. This report also reveals and discusses certain test results categorized as new technology wherein this investigation and its results might be applicable in other areas not necessarily directly related to the specific task of this NASA contract.

RESULTS.

The results of this contract indicate that the requirements of the Scope of Work of the subject NASA contract have been met either by the specific result of a test or tests or by the obvious correctly applied interpolation of acquired data either by observation or instrument.

For the required results, reference is made to Article I - Scope of Work of the subject NASA contract.

CONCLUSIONS.

1. The nose cone configuration employed is an effective repeating method for dissipation of the imposed impact forces.

2. The final nose cone configuration is a re-useable assembly.

3. The parachute and its deployment method employed are both reliable and effective.

4. Modifications to the Recorder Capsule are easily made with minimal disturbance to the existing components.

5. Time delay after ejection from a vehicle at altitude should be increased to 20 seconds to minimize drift in a normally encountered wind profile such as during tests at SPACE Corp.

6. Refurbishment of the Modified Recorder Capsule after recovery is easily and quickly accomplished.

7. The existing size of the tail fins contribute little to the free fall tumbling stability of the Capsule, especially if the Capsule were ejected horizontally. It is recommended that the fins be omitted entirely or that their size and location be such that their effectiveness be realized and therefore justified.

8. From appraisal of the tested unit, it is possible that the existing Recorder Capsule Assembly may be capable of withstanding higher impact forces than the presently established maximum of 10 G's for 50 milliseconds. If this were true obvious advantages could be taken of a higher descent rate for minimum drift, smaller parachute, less weight, etc.

9. Even though impact distances shown for both the Dummy and Modified Recorder were in excess of 1,000 feet from "drop point", it can be seen that the existing wind profile at test could easily cause drift of such magnitude. It can also be

seen that by correlation and interpolation that if the "Scope of Work Wind Profile" had existed, the drift and impact distance requirement could have very nearly been met if deployment of the parachute had occurred at very nearly drop or release altitude, instead of deployment altitude.

WORK PHASES.

In accordance with Article I - Scope of Work, the task was basically performed in three phases:

Phase I - Design
Phase II - Dummy Recorder Capsule
Phase III - Modified Recorder Capsules

During Phase I, the contractor also performed extensive tests on various nose cone configurations in order that the nose cone configuration be finalized for the desired shock mitigation characteristics.

For the purposes of this report Phase II and Phase III, design and fabrication of the Dummy Recorder Capsule and design of the Modified Recorder Capsules were performed concurrently.

DEVELOPMENT - NOSE CONE.

Requirements to be met by the nose cone were generally established as follows:

a. Inexpensive.

b. Lightweight.

c. Easily replaceable or reuseable.

d. Compact.

e. Capable of dissipating the energy of a 20 pound weight falling at 16 feet per second so as to limit the impact forces to 10 G's for 50 milliseconds duration.

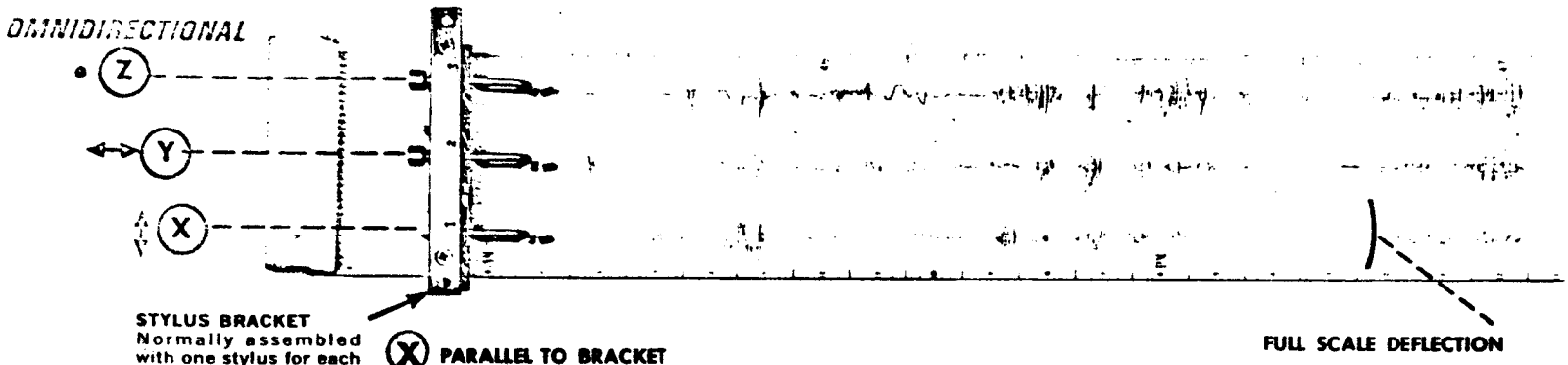
Original evaluation of paper honeycomb structures and available vendor data indicated that the use of a specifically developed nose cone configuration of paper honeycomb would yield the desired shock mitigation characteristics. This is indicated by the originally proposed and submitted nose cone configuration as part of Phase I "preliminary design layout . . . .". However, extensive tests at SPACE Corp. revealed that the honeycomb stack configuration would result in an unacceptable dimensional envelope and would lack acceptable repeatability. Following these initial tests it was determined that another nose cone configuration would be required. Consequently, further tests ensued to arrive at the nose cone configuration that possessed desirable dimensional envelope characteristics, good repeatability, and simple in its construction.

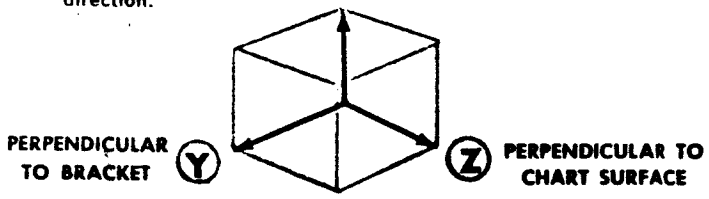
The following chart sections are the results of this investigation.

Figure 1 shows the operating configuration of the Impact Recorder utilized for all evaluations in this testing. The impact stylus assembly utilized was of the omnidirectional type although only "X" axis information was sought for the longitudinal axis.

1 Select Correct Stylus Assembly

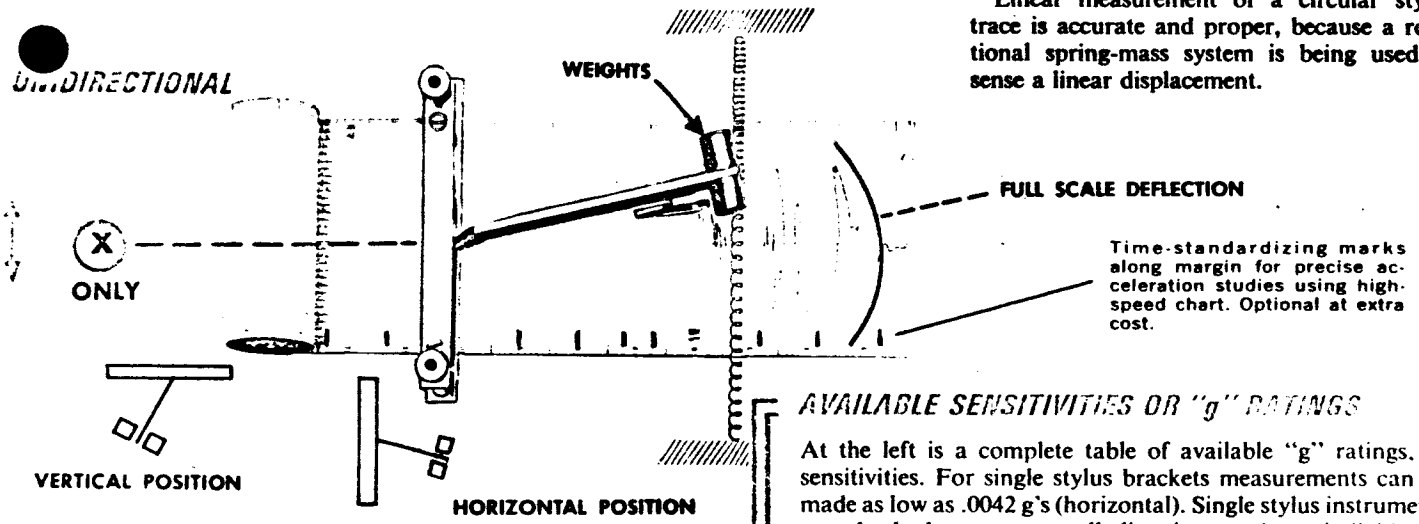
A. SENSITIVITY **B. FORCE DIRECTIONS**





Each stylus moves in the *same plane* to facilitate recording and convenient reading of the graph. The "x" and "y" inertia masses also move in this *plane*; while the "z" mass or weight moves in the mutually perpendicular plane as shown by the dot (end-view of arrow).

Linear measurement of a circular stylus trace is accurate and proper, because a rotational spring-mass system is being used to sense a linear displacement.



Sensitivity ("g's")	Natural Frequency (f_n, cps)	Critical Pulse Duration (milliseconds)†
2*	8.5	58.8
4*	10.0	50.0
6	12.5	40.0
15	19.5	25.6
30	23.0	21.8
50	25.0	20.0
70	27.0	18.5
100	29.7	16.6
200	35.0	14.3
300	38.0	13.2

*Special bracket † ($=1000/2f_n$)

FIGURE 1

AVAILABLE SENSITIVITIES OR "g" RATINGS

At the left is a complete table of available "g" ratings, or sensitivities. For single stylus brackets measurements can be made as low as .0042 g's (horizontal). Single stylus instruments may be had to measure all directions and are individually calibrated for both horizontal and vertical operation. Brackets have been assembled in which all three styli monitor the same plane but with different sensitivities (e.g. 6X15X50X). Packages which weigh less than one hundred pounds (and can be thrown) may experience 70g to 100g. For heavier packages you should specify a sensitivity of 6, 15, 30, or 50g—depending on fragility and the amount and type of cushioning material. Vehicle suspension monitoring may require a sensitivity of 0.5g (for passenger cars over boulevards and expressways) or 15g (for tanks over rough terrain) assuming the recorder is *secured inside the vehicle*. For freight cars: the "g" equivalent to what is called a "10 mph impact" is 15. For piggy-back applications: a 6X15Y6Z Impact-O-Graph is often attached to the *trailer*. Also used in freight cars to amplify markings of lateral and vertical shocks and oscillations.

Impact-O-Graphs are often used in pairs: one attached to the lading (a) and the other attached to the vehicle (b). If (a) doesn't show less impact than (b) the packaging, blocking, or bracing are clearly inefficient.

Figure 2 is a chart sample from the Impact Recorder utilized for the drop tests. Markings shown on this sample have no relation to any specific test.

TABLE I

CALIBRATION TABLE FOR 15g SENSITIVITY FOR IMPACT RECORDER

INCHES*	SPACES*	"g"*
1/8	1	2.7
1/4	2	5.5
3/8	3	8.2
1/2	4	10.9
5/8	5	13.6
6/8	6	16.3

*As read from centerline.

Figure 3 shows the configuration of the drop test fixture wherein the assembly is shown at drop height required to produce 10g impact for the capsule weight at ground impact. Although the final nose cone configuration is shown, this test set-up was utilized for all configurations tested. This Figure 2 shows the impact stylus assembly mounted inside its case with a battery/motor driven chart drive.

Figure 4 shows the test drop assembly in the released or impact position.

Figures 5 and 6 show typical paper honeycomb configurations tested and the resulting shapes assumed by the assemblies as the result of impact. The most notable feature of these configurations is their evidence of column failure, which was found to cause secondary impact results such as to exceed the specified limits of 10 g's. With reference to Configuration #1 of Figure 5, it is evident here that more length is required. However, in the process

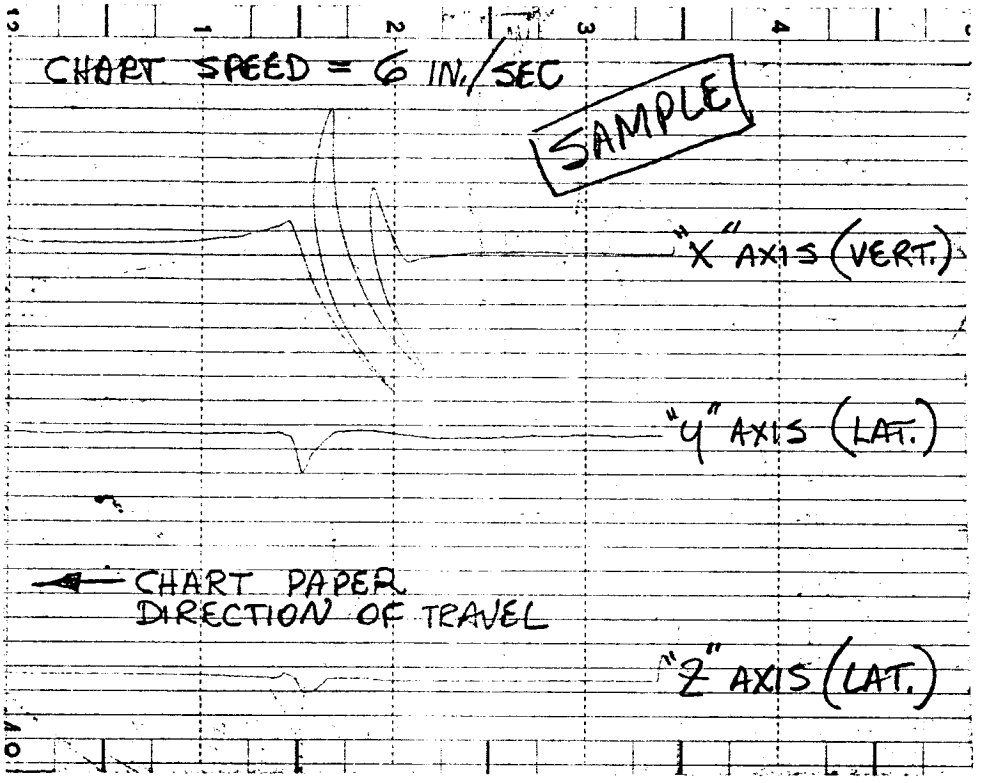


CHART SAMPLE
FROM IMPACT-O-GRAPH
IMPACT RECORDER

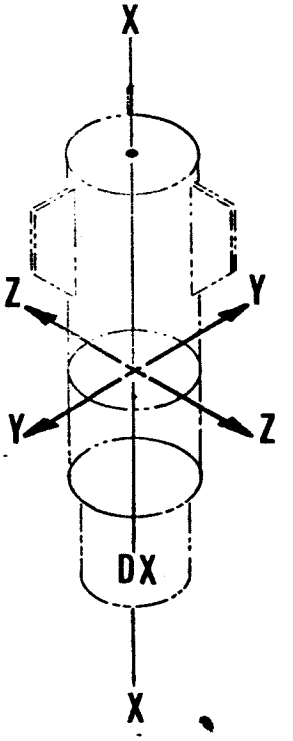


FIGURE 2

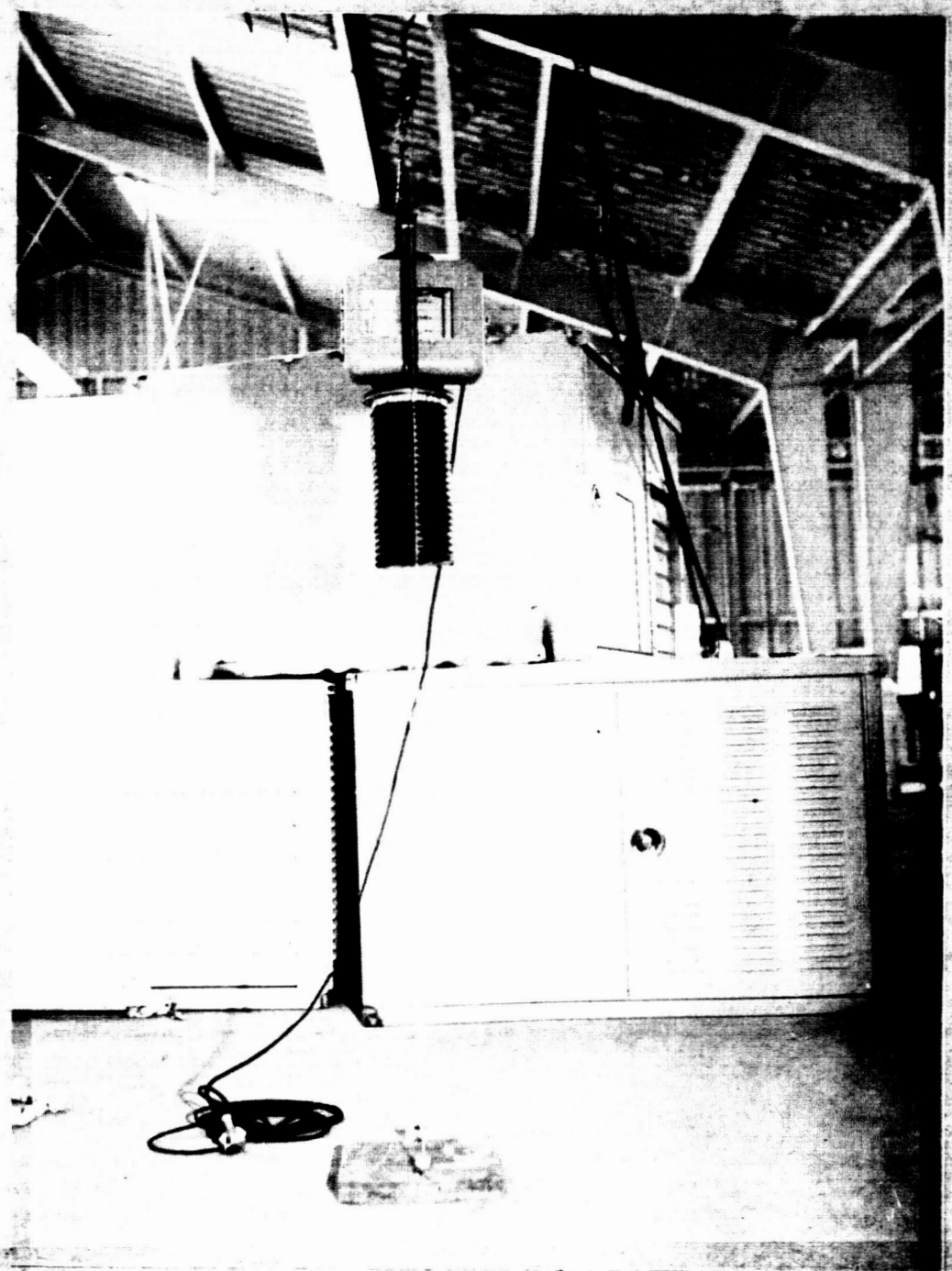


FIGURE 3

DROP TEST FIXTURE AND ARRANGEMENT

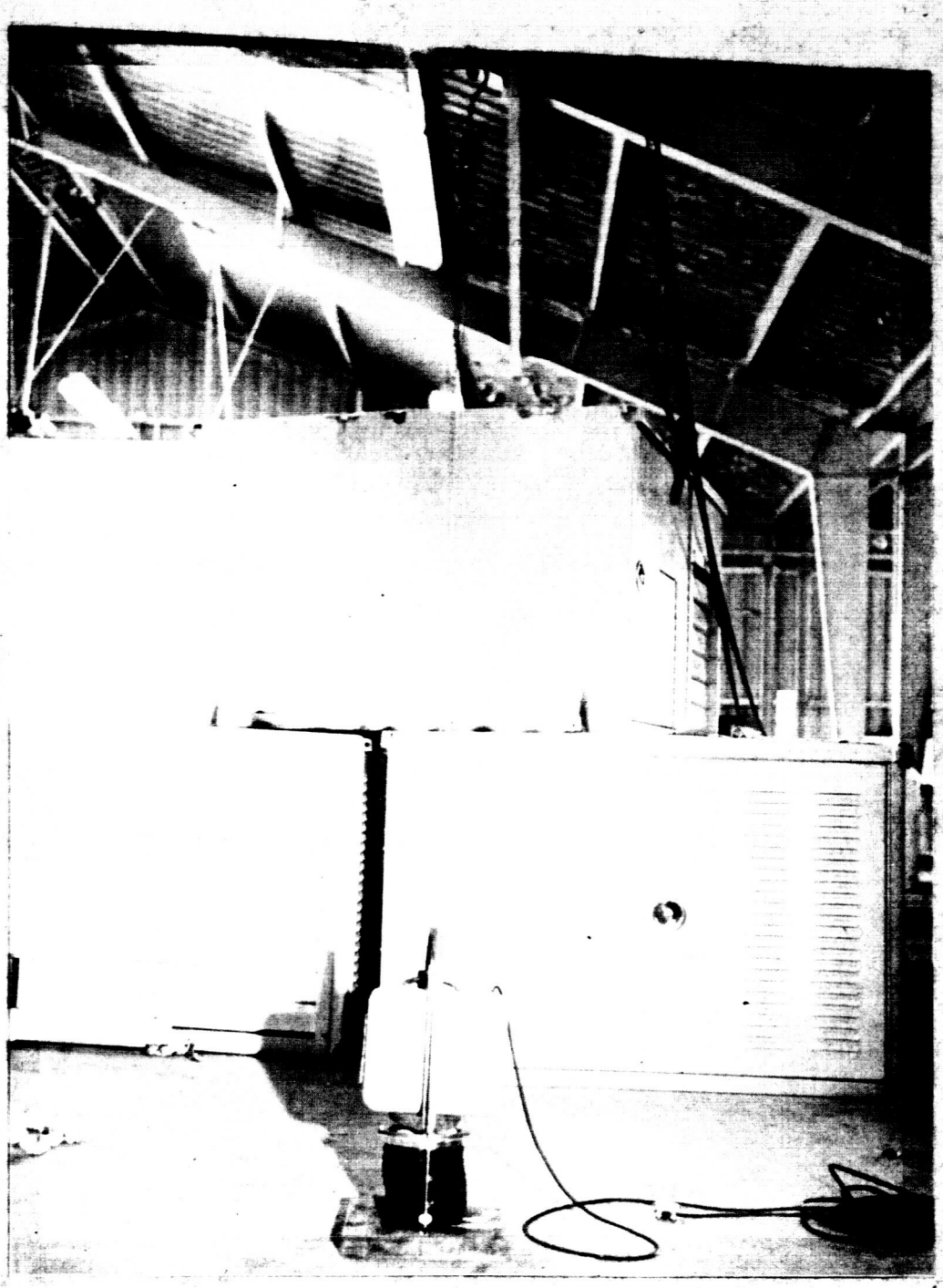


FIGURE 4

DROP TEST ARRANGEMENT IN "IMPACT" POSITION

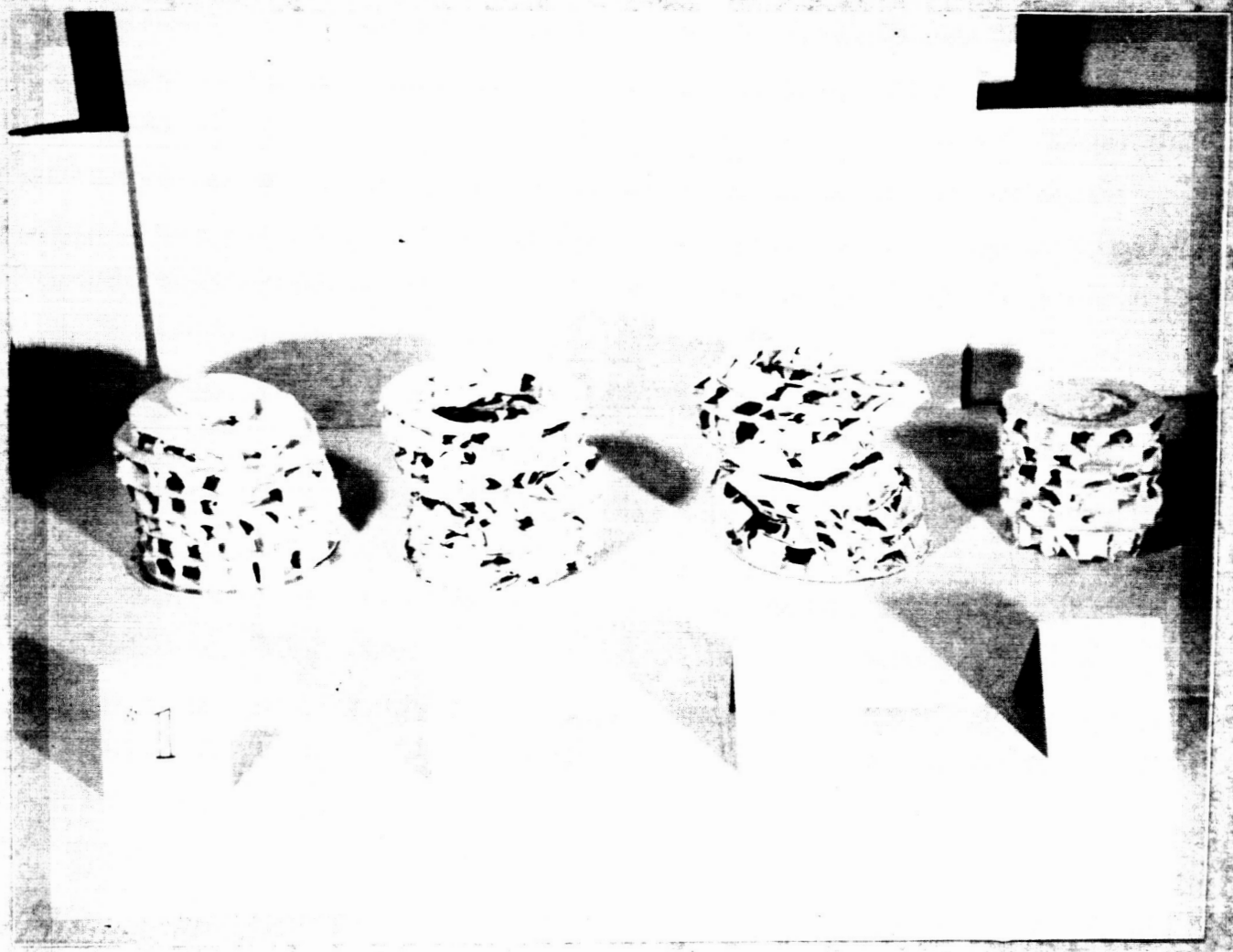


FIGURE 5

TYPICAL TESTED PAPER HONEYCOMB
NOSE CONE CONFIGURATIONS

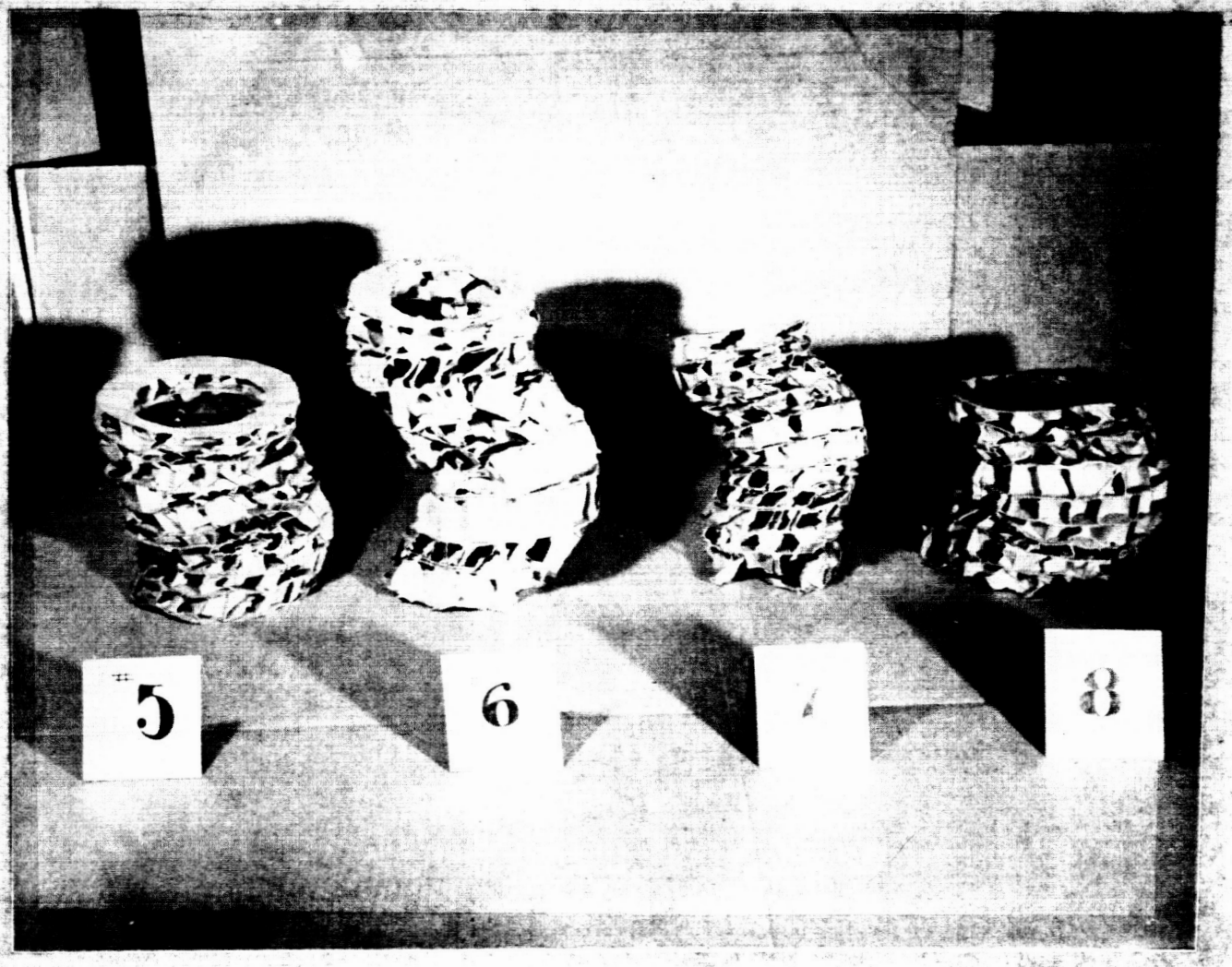


FIGURE 6

TYPICAL TESTED PAPER HONEYCOMB
NOSE CONE CONFIGURATIONS

of lengthening the configuration, the column failures resulted. Also, Figure 5 and Figure 6 shows specifically the configurations used for the results shown for Charts #1 through #8. Test #1 shows that the configuration caused impact to exceed 16 g's, requiring a "softer" configuration in the form of length and less effective cross-section. Test #7 shows the results of the "softer" configuration wherein initial "g" impact was less than 10, but that column failure and subsequent "bottoming out" caused a peak impact in excess of 10 g's, followed by considerable rebounding before stabilization.

Figure 7 is a photograph typical of the paper honeycomb utilized in the tests shown in Figures 5 and 6.

Strip Chart results exhibited as Tests #1 through #150 are the chronological sequence of nose cone configuration testing in arriving at the final configuration and show nose cone configurations correlated to test drop numbers.

Strip Chart results, Tests #1A through #6A (Pages 116-119) are the verification test drops of the finalized Dummy Recorder Capsule Assembly (SPACE Corp. Drawing 2101-100).

NOTE

In all cases, the chart speed was 6 inches per second and the weight as sensed by the nose cone was 20.0 pounds plus .5 pounds, minus zero pounds.

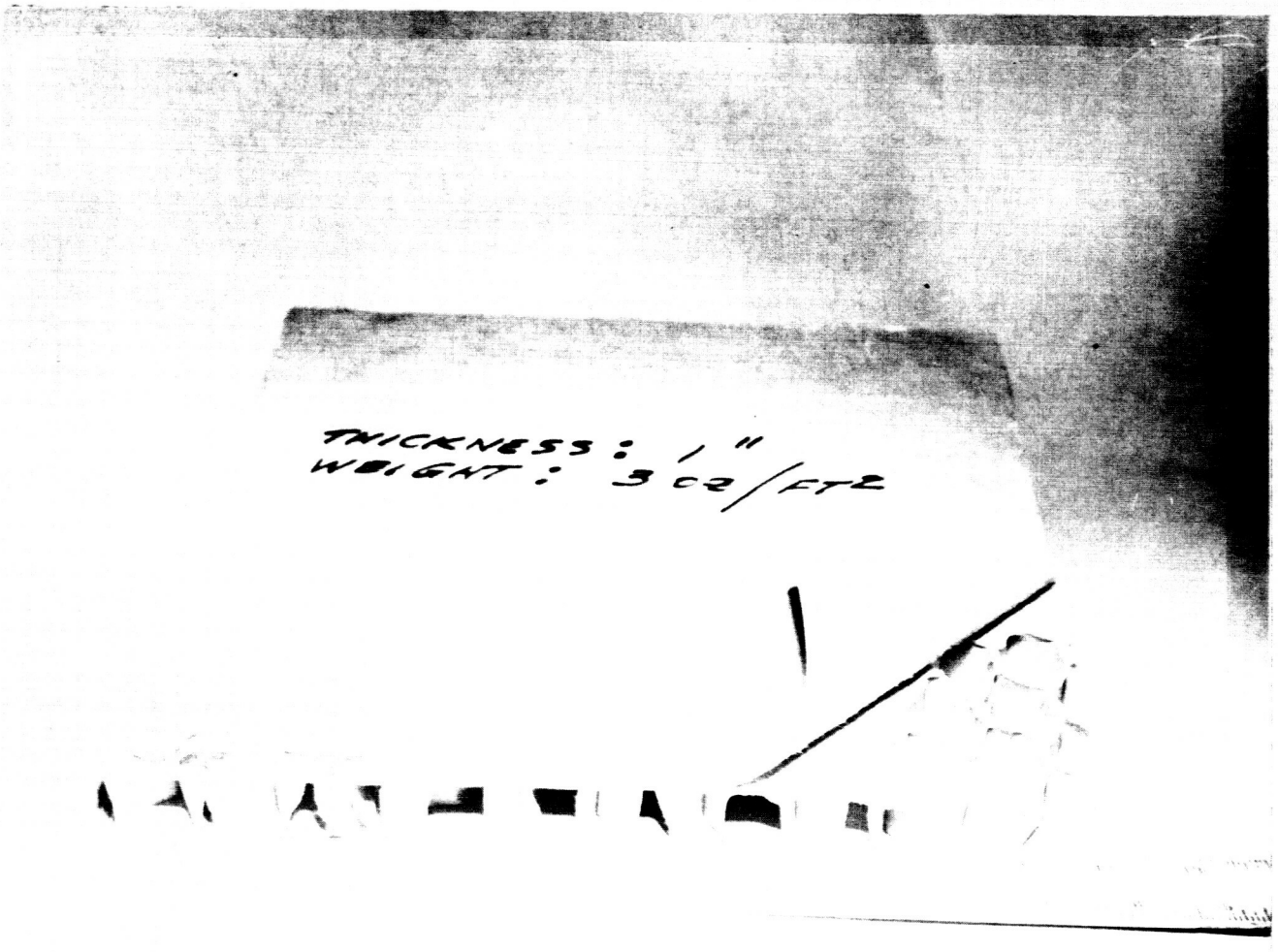
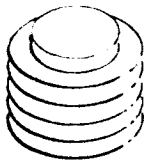


FIGURE 7

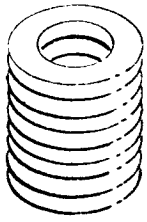
PAPER HONEYCOMB TESTED



DESCRIPTION: 5 rings of 1" thick kraft paper, honeycomb, 6-1/4" OD, and 1 ring 1" thick, 2-1/2" OD.

REMARKS: Unsatisfactory impact results. See Strip Chart #1 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound.

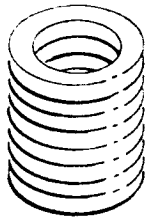
TEST #1



DESCRIPTION: 8 rings of 1" thick kraft paper, honeycomb, 6-1/2" OD by 4-1/4" ID.

REMARKS: Unsatisfactory impact results. See Strip Chart #2 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound.

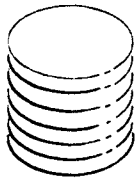
TEST #2



DESCRIPTION: 8 rings of 1" thick kraft paper, honeycomb, 6-1/4" OD by 5" ID.

REMARKS: Unsatisfactory impact results. See Strip Chart #3 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound. Evidence of column failure.

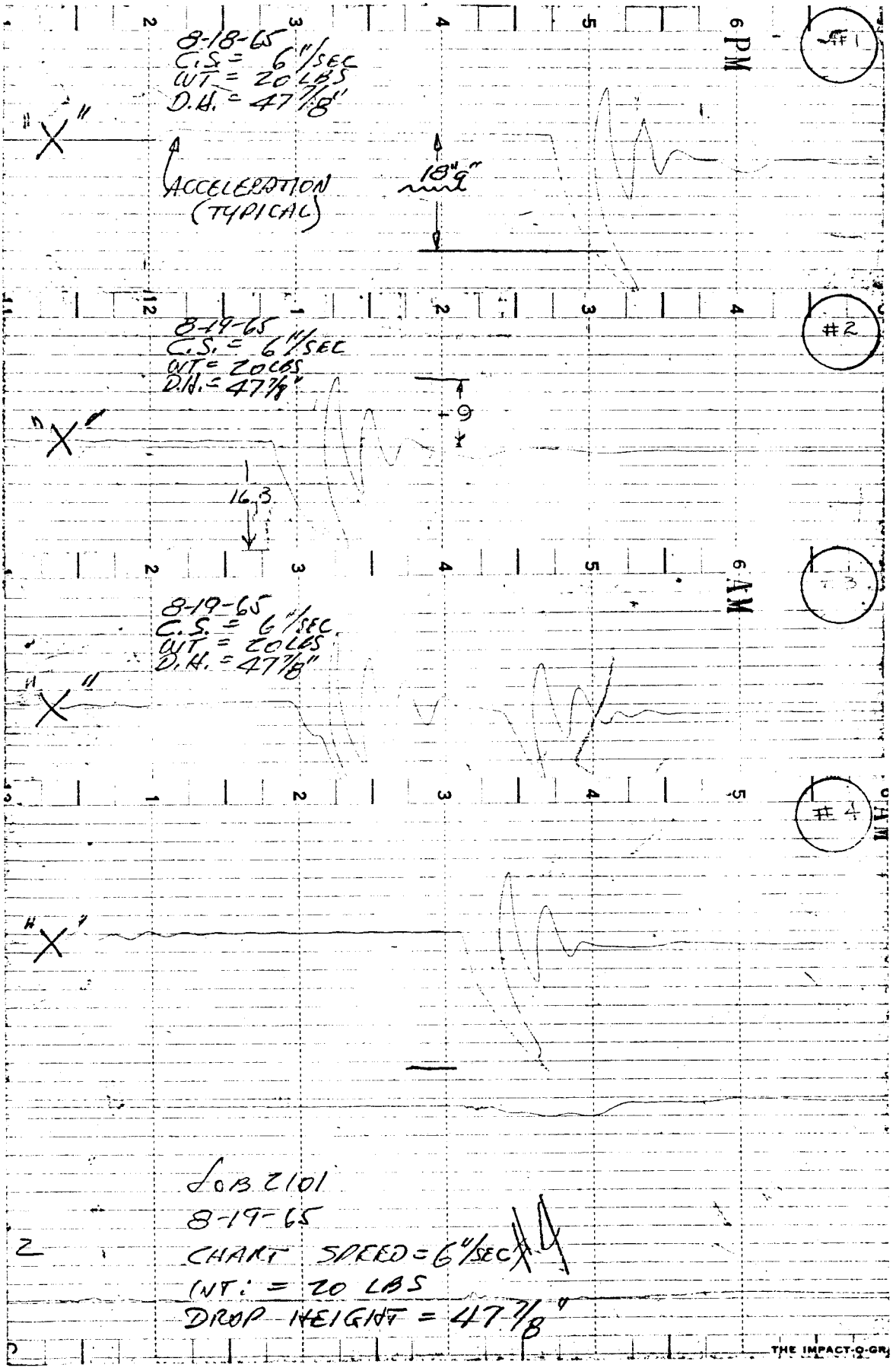
TEST #3

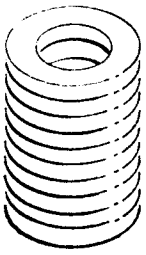


DESCRIPTION: 6 rings of 1" thick kraft paper, honeycomb, 5" diameter.

REMARKS: Unsatisfactory impact results. See Strip Chart #4 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound. Evidence of column failure.

TEST #4

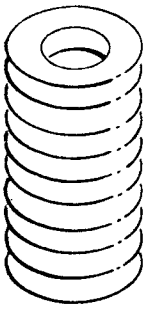

8-18-65
C.S. = 6"/SEC
WT = 20 LBS
D.H. = 47 7/8"
ACCELERATION (TYPICAL)
18 1/2"
#1
6 PM
8-19-65
C.S. = 6"/SEC
WT = 20 LBS
D.H. = 47 7/8"
9
16.3
#2
8-19-65
C.S. = 6"/SEC
WT = 20 LBS
D.H. = 47 7/8"
#3
6 AM
#4
LOB 2101
8-19-65
CHART SPEED = 6"/SEC
WT. = 20 LBS
DROP-HEIGHT = 47 7/8"
THE IMPACT-O-GR



DESCRIPTION: 10 rings of 1" thick kraft paper, honeycomb, 6-1/4" OD by 4-1/4" ID.

REMARKS: Unsatisfactory impact results. See Strip Chart #5 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound. Evidence of column failure.

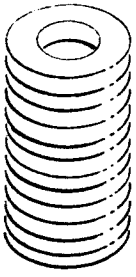
TEST #5



DESCRIPTION: 9 rings of 1-1/2" kraft paper, honeycomb, 6-1/4" OD by 4-1/4" ID.

REMARKS: Unsatisfactory impact results. See Strip Chart #6 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound. Evidence of column failure.

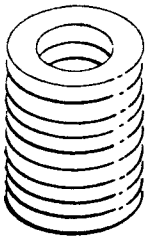
TEST #6



DESCRIPTION: 12 rings of 1" kraft paper, honeycomb, 4-5/8" OD by 2-5/8" ID.

REMARKS: Unsatisfactory impact results. See Strip Chart #7 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound. Evidence of column failure.

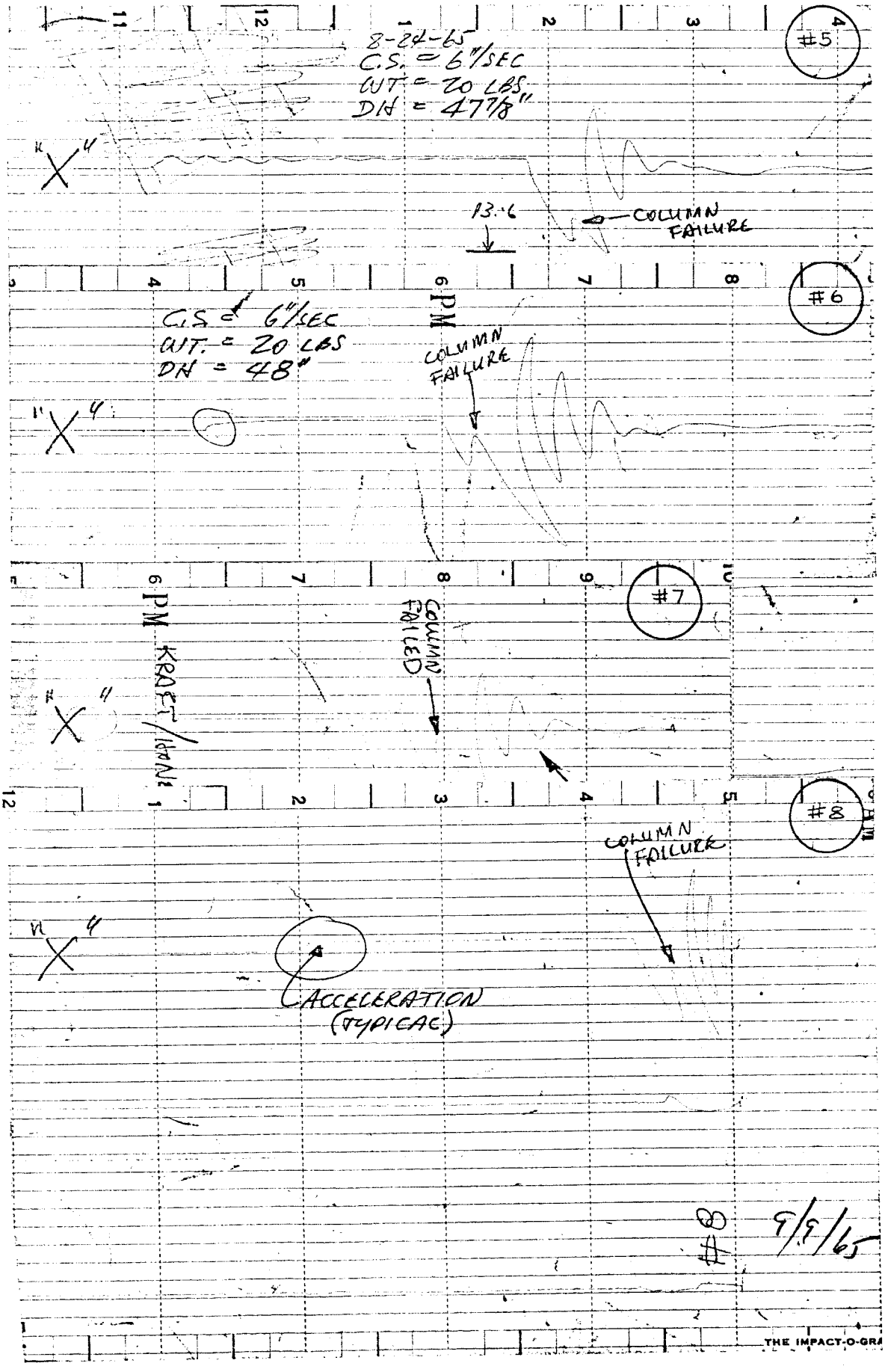
TEST #7

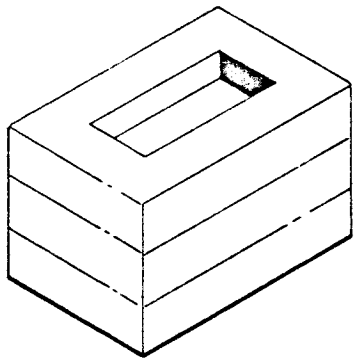


DESCRIPTION: 9 rings of 1" kraft paper, honeycomb, 6-1/2" OD by 4-1/2" ID.

REMARKS: Unsatisfactory impact results. See Strip Chart #8 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound. Evidence of column failure.

TEST #8


8-24-65
C.S. = 6"/SEC
WT = 20 LBS.
DH = 47 7/8"
#5
13.6
COLUMN FAILURE
#6
C.S. = 6"/SEC
WT. = 20 LBS
DH = 48"
6 PM
COLUMN FAILURE
#7
6 PM KRAFT/HAND
COLUMN FAILED
#8
COLUMN FAILURE
ACCELERATION (TYPICAL)
#8 9/9/65
THE IMPACT-O-GRA

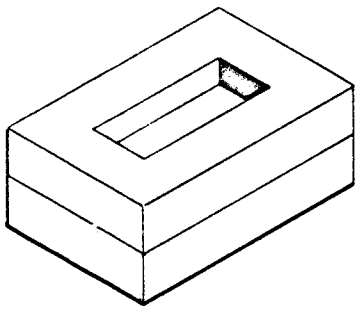


Hard
Hard
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell hard polyurethane with 3" by 6" cavities.

REMARKS: Unsatisfactory impact results. See Strip Chart #9 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound.

TEST #9

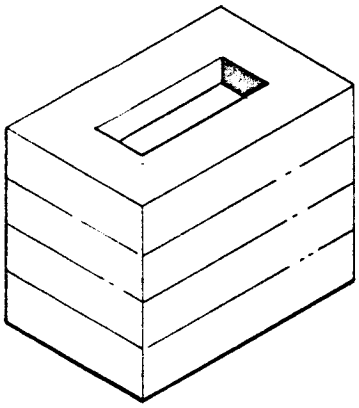


Hard
Hard

DESCRIPTION: 2 layers of 4" thick 9" by 12" open cell hard polyurethane with 3" by 6" cavities.

REMARKS: Unsatisfactory impact results. See Strip Chart #10 for specific characteristics. Impact considerably in excess of 10 G's. Unsatisfactory rebound.

TEST #10

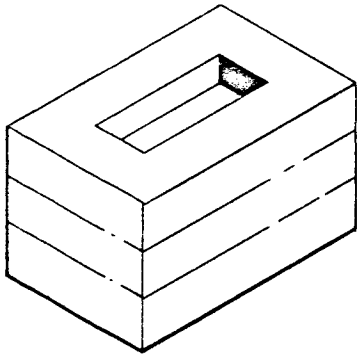


Soft
Soft
Hard
Hard

DESCRIPTION: 4 layers of 4" thick 9" by 12" open cell alternate soft and hard polyurethane with 3" by 6" cavities.

REMARKS: Satisfactory impact results (8.2 G's), however, stacked height of the test configuration and its size not conducive to use as a shock mitigation device for this application.

TEST #11

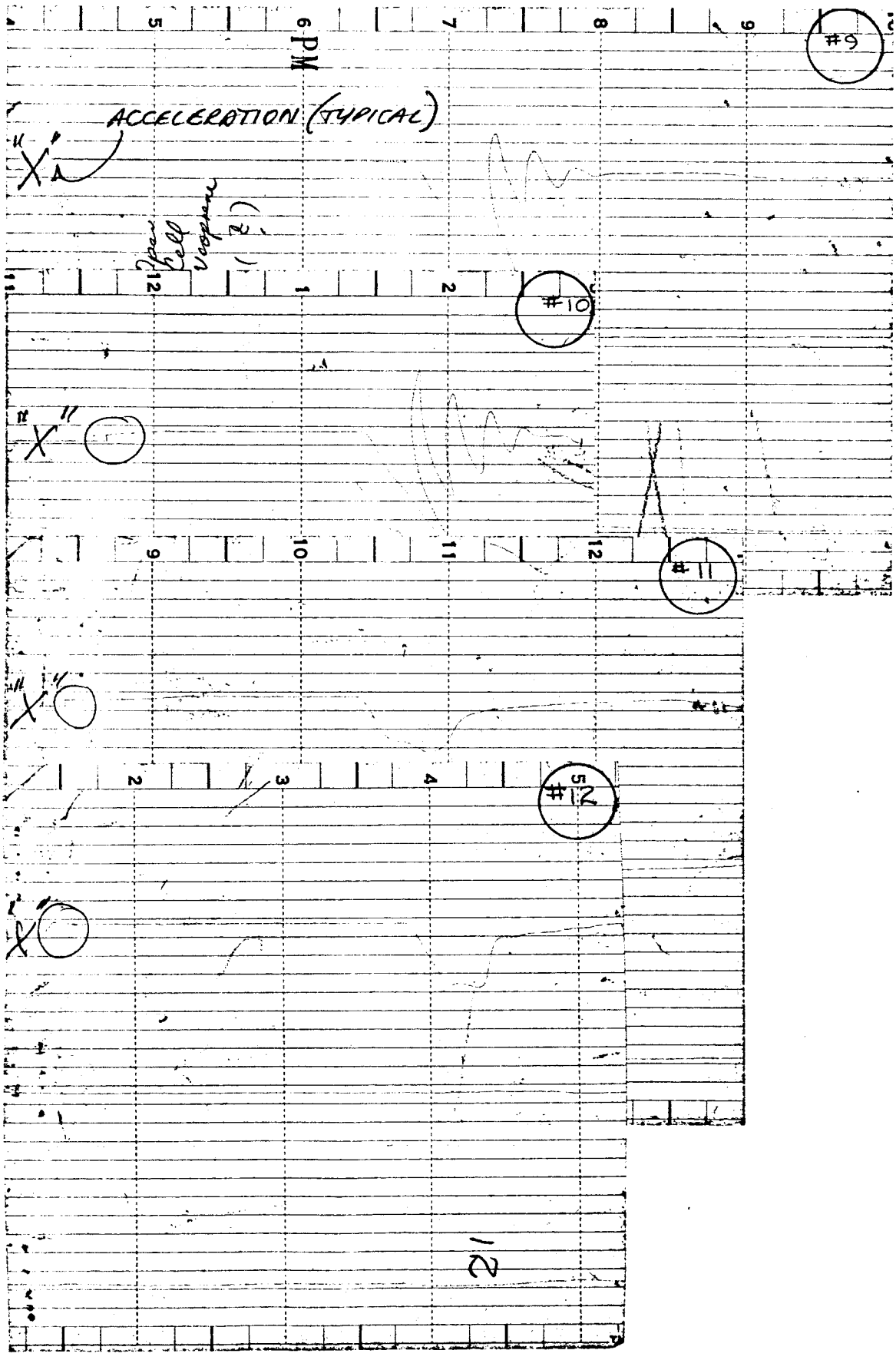


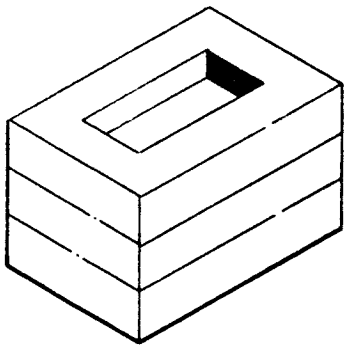
Soft
Hard
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell alternate soft and hard polyurethane with 3" by 6" cavities.

REMARKS: Satisfactory impact results (9.5 G's), however, stacked height of the test configuration and its size not conducive to use as a shock mitigation device for this application.

TEST #12


PM
ACCELERATION (TYPICAL)
#9
#10
#11
#12



Soft
Soft
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell alternate hardness polyurethane with 3" by 6" cavities.

REMARKS: Unsatisfactory impact results. See Strip Chart #13 for specific characteristics. Impact in excess of 10 G's.

TEST #13

Hard
Soft
Hard

Configuration Same as Above

DESCRIPTION: 3 layers of 9" by 12" (one 3" thick, two 4" thick) open cell polyurethane with 3" by 6" cavities. Alternate hardness as shown.

REMARKS: Unsatisfactory impact results. See Strip Chart #14 for specific characteristics. Impact in excess of 10 G's.

TEST #14

Hard
Soft
Soft

Configuration Same as Above

DESCRIPTION: 3 layers of 9" by 12" (one 3" thick, two 4" thick) open cell polyurethane with 3" by 6" cavities. Alternate hardness as shown.

REMARKS: Unsatisfactory impact results. See Strip Chart #15 for specific characteristics. Impact in excess of 10 G's.

TEST #15

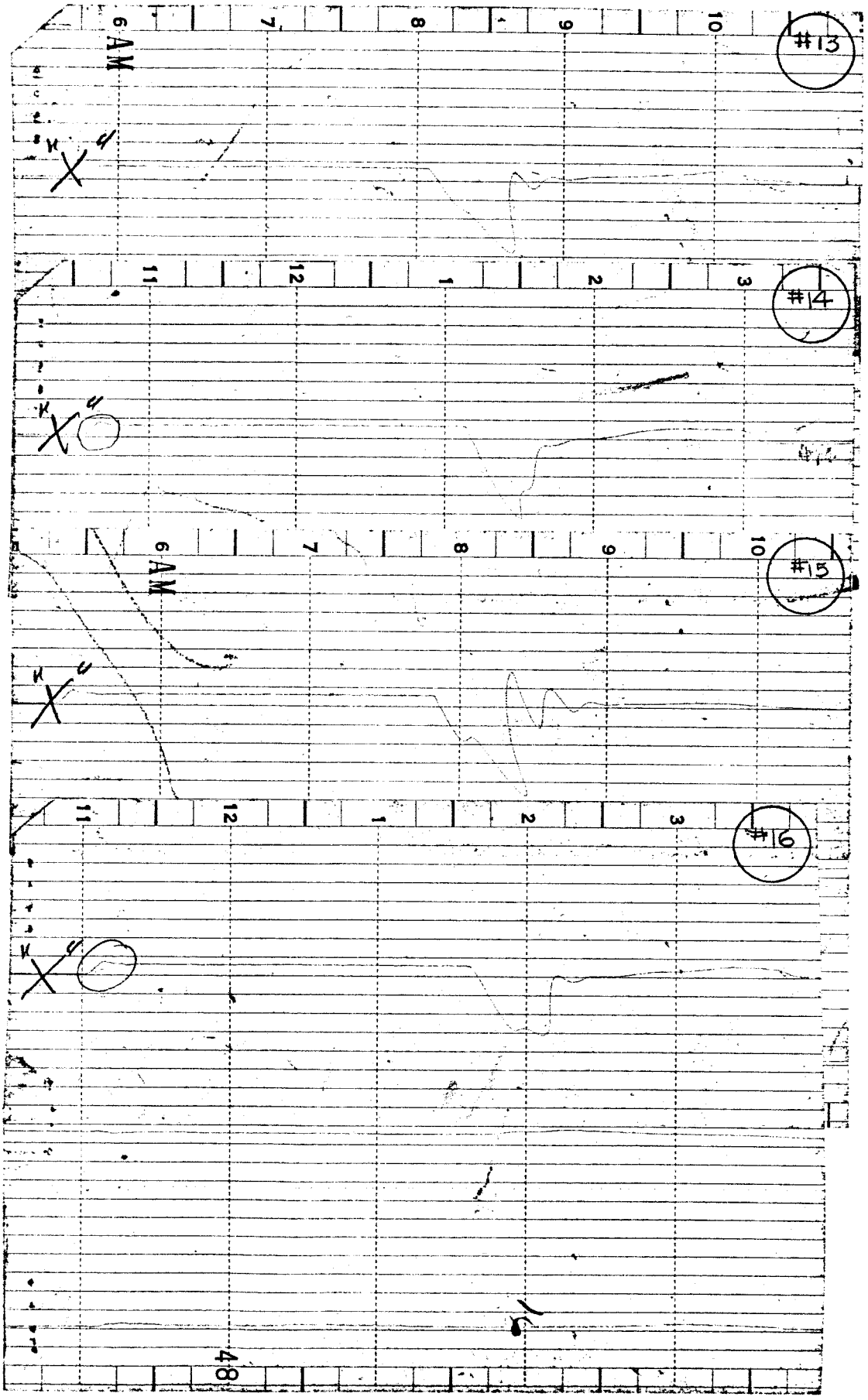
Soft
Hard
Hard

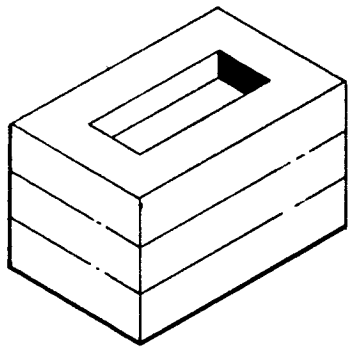
Configuration Same as Above

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell alternate hardness polyurethane with 3" by 6" cavities.

REMARKS: Satisfactory impact results (9.5 G's), however, stacked height and dimensional configuration not considered satisfactory for shock mitigation system for this application.

TEST #16


6 AM
7
8
9
10
#13
11
12
1
2
3
#14
6 AM
7
8
9
10
#15
11
12
1
2
3
#16
48



Hard
Soft
Hard

DESCRIPTION: 3 layers of 4" thick 9" x 12" open cell alternate hardness polyurethane with 3" by 6" cavities.

REMARKS: Impact results in excess of 10 G's. Refer to Strip Chart #17 for specific characteristics. Form of the curve approximates that desired. Repeatability check (11.6 G's).

TEST #17

DESCRIPTION: 3 layers of 4" thick 9" x 12" open cell alternate hardness polyurethane with 3" by 6" cavities.

Configuration Same as Above

Hard
Hard
Soft

REMARKS: Impact results in excess of 10 G's. Refer to Strip Chart #18 for specific characteristics. Form of the curve approximates that desired. Repeatability check (11.6 G's).

TEST #18

DESCRIPTION: 3 layers of 4" thick 9" x 12" open cell alternate hardness polyurethane with 3" by 6" cavities.

Configuration Same as Above

Hard
Hard
Soft

REMARKS: Impact results in excess of 10 G's. Refer to Strip Chart #19 for specific characteristics. Form of the curve approximates that desired. Repeatability check (11.6 G's).

TEST #19

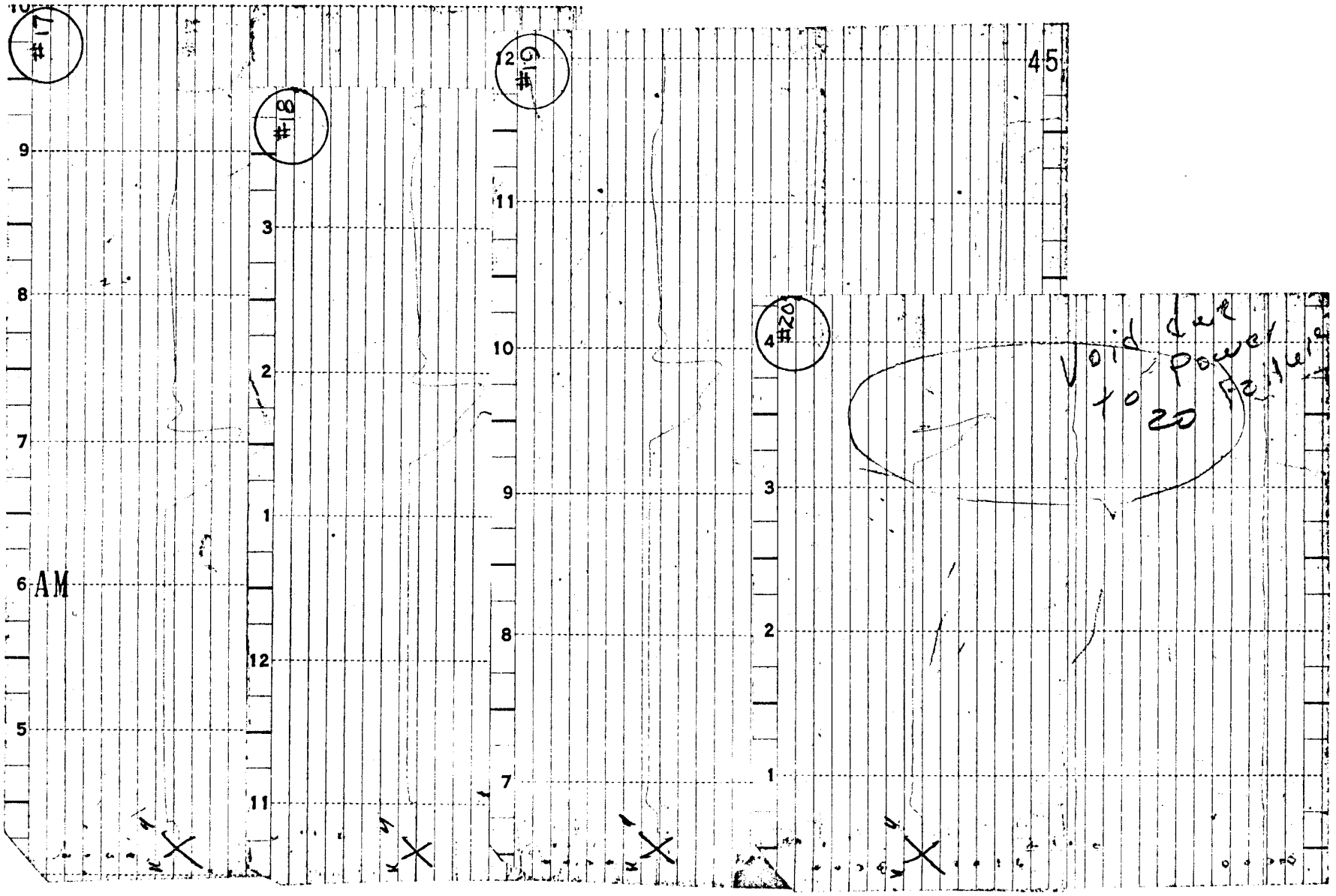
DESCRIPTION: 3 layers of 4" thick 9" x 12" open cell alternate hardness polyurethane with 3" by 6" cavities.

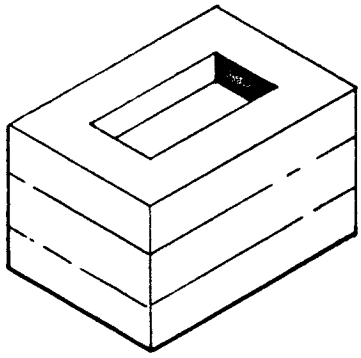
Configuration Same as Above

Hard
Hard
Soft

REMARKS: Impact results in excess of 10 G's. Refer to Strip Chart #20 for specific characteristics. Form of the curve approximates that desired. Repeatability check (11.6 G's).

TEST #20


#17
#18
#19
#20
45
AM
Void due
Power Failure
to 20

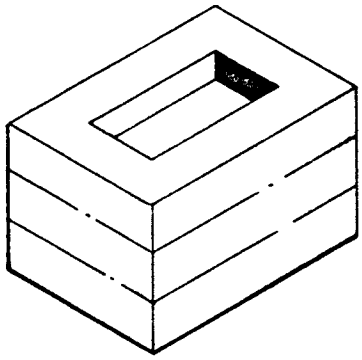


Hard
Hard
Soft

DESCRIPTION: 3 layers of 4" thick 9" x 12" open cell alternate hardness polyurethane with 3" x 6" cavities.

REMARKS: Impact results in excess of 10 G's. See Strip Chart #21 for specific characteristics. Form of the curve approximates that desired. Repeatability check (11.6 G's).

TEST #21

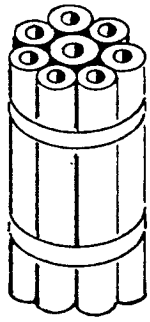


Hard
Hard
Soft

DESCRIPTION: 3 layers of 4" thick 9" x 12" open cell alternate hardness polyurethane with 3" x 6" cavities.

REMARKS: Impact results in excess of 10 G's. See Strip Chart #22 for specific characteristics. Form of the curve approximates that desired. Repeatability check (11.6 G's).

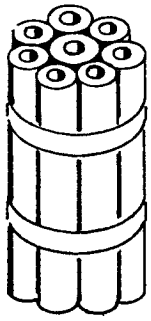
TEST #22



DESCRIPTION: 8 pieces 1-5/8 OD by 5/8 ID 8" long of Armstrong Armaflex tubing taped into a bundle for a total column effect.

REMARKS: Impact results considerably in excess of 10 G's (19). See Strip Chart #23 for specific characteristics. Undesirable column failure and rebound characteristics.

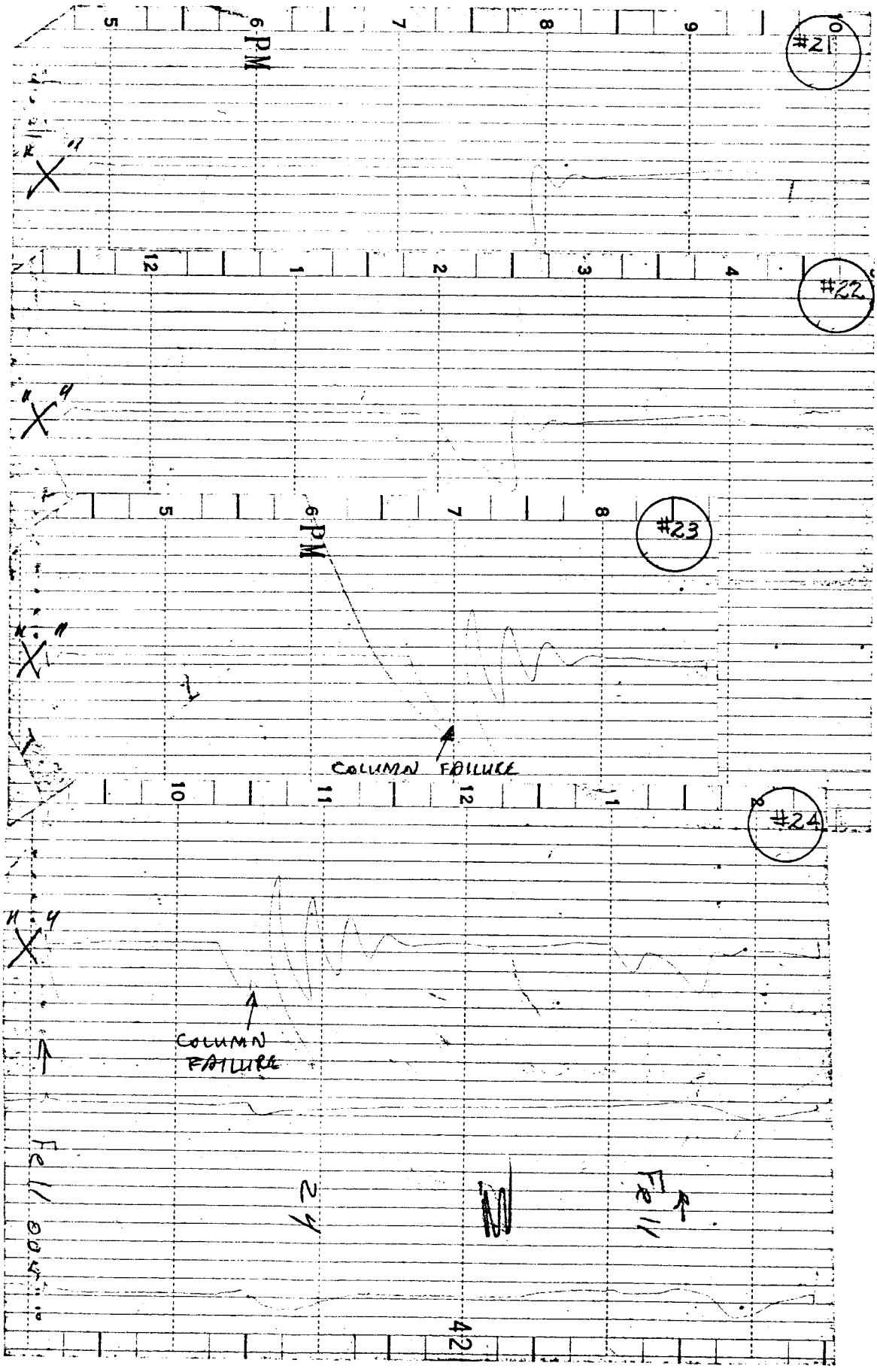
TEST #23

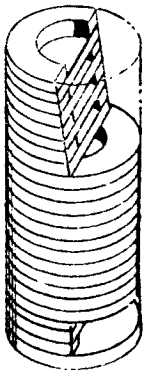


DESCRIPTION: 8 pieces 1-5/8 OD by 5/8 ID 8" long of Armstrong Armaflex tubing taped into a bundle for a total column effect.

REMARKS: Impact results considerably in excess of 10 G's (19). See Strip Chart #24 for specific characteristics. Undesirable column failure and rebound characteristics.

TEST #24

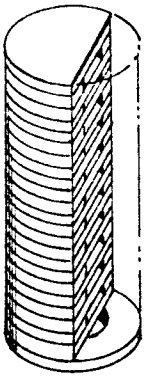

#21
#22
#23
#24
6 PM
6 PM
COLUMN FAILURE
COLUMN FAILURE



DESCRIPTION: Alternating 1/2" thick sponges 6-1/4" diameter and 6-1/4 OD by 4-1/4 ID for a total stack height of 9". Solid sponge plate at bottom. Material: neoprene.

REMARKS: Impact results in excess of 10 G's. Undesirable rebound characteristics. See Strip Chart #25 for specifics.

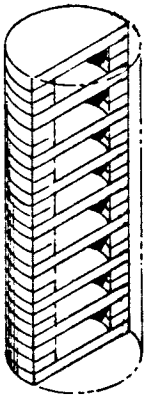
TEST #25



DESCRIPTION: Alternating 1/2" thick sponges 6-1/4" diameter and 6-1/4 OD by 4-1/4 ID for a total stack height of 9". Sponge ring was used at bottom and solid sponge plate at top. Material: neoprene.

REMARKS: Impact results in excess of 10 G's. Undesirable rebound characteristics. See Strip Chart #26 for specifics.

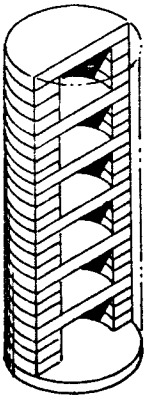
TEST #26



DESCRIPTION: Alternating 1/2" thick sponges 6-1/4" diameter and 6-1/4 OD by 4-1/4 ID for a total stack height of 9". Solid sponge plate at bottom with two intermittent rings between alternating solid sponge plates. Material: neoprene.

REMARKS: Impact results in excess of 10 G's. Undesirable rebound characteristics. See Strip Chart #27 for specifics.

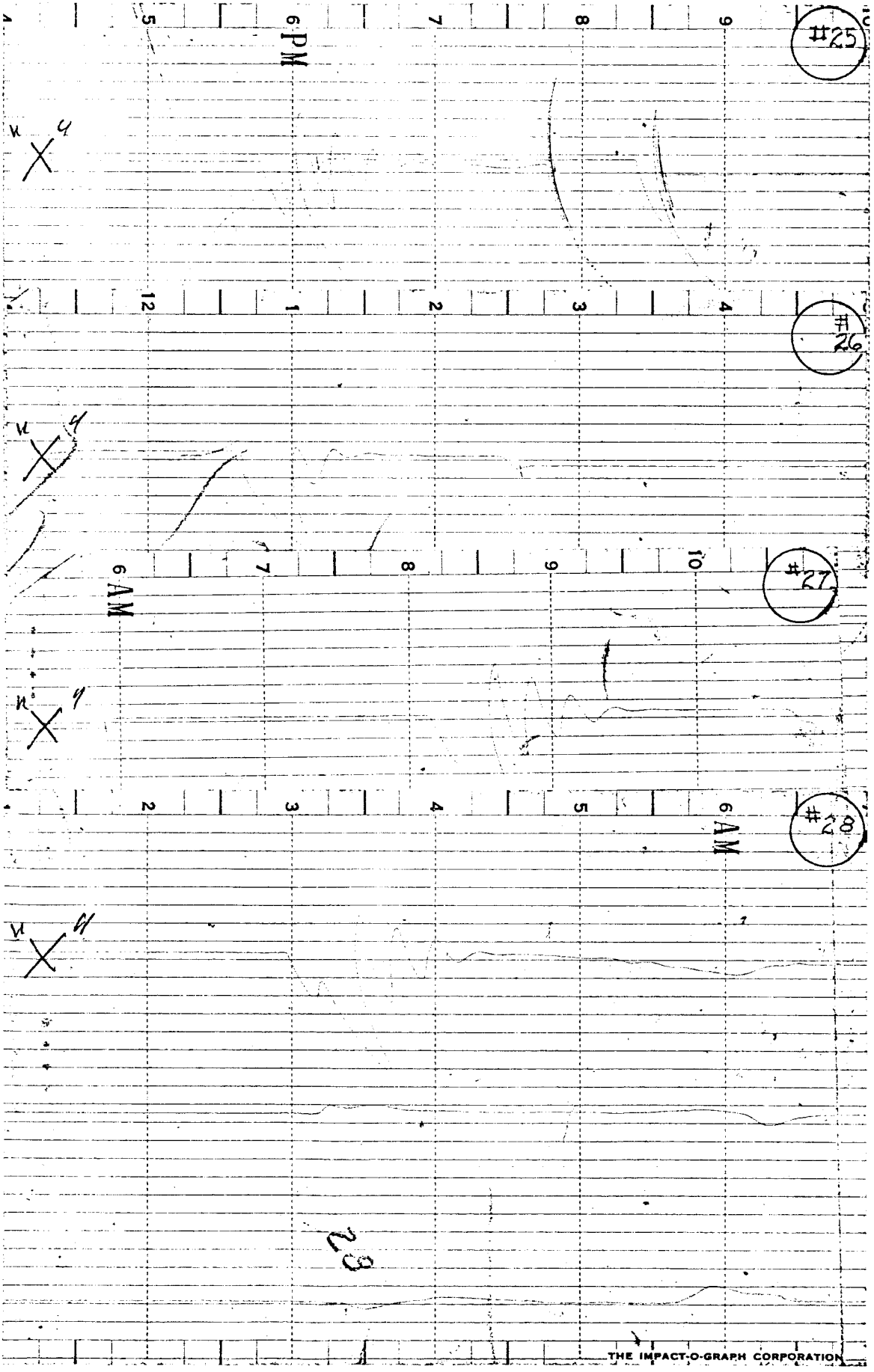
TEST #27

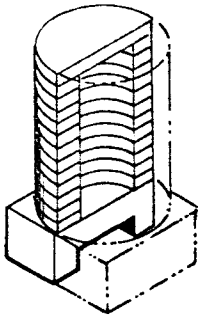


DESCRIPTION: Alternating 1/2" thick sponges 6-1/4" diameter and 6-1/4 OD by 4-1/4 ID for a total stack height of 9". Solid sponge plate at bottom with three intermittent rings between alternating solid sponge plates. Material: neoprene.

REMARKS: Impact results in excess of 10 G's. Undesirable rebound characteristics. See Strip Chart #28 for specifics.

TEST #28

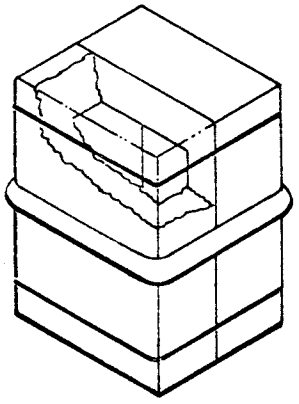

#25
6 PM
#26
#27
6 AM
#28
6 AM
28
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 13 rings of 1" thick neoprene sponge rubber 6-1/4 OD by 4-1/4 ID with solid 6-1/4" diameter sponge plate top and bottom. Total stack mounted on a kraft paper box enclosure.

REMARKS: Impact results in excess of 10 G's. Assembly exhibited undesirable column failure. Unsatisfactory rebound characteristics. See Strip Chart #29 for specifics.

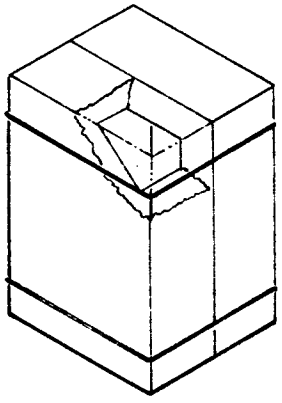
TEST #29



DESCRIPTION: 2 9" by 12" open cell hard polyurethane blocks with 3" by 6" cavities assembled as shown with "Bungee" cord and wire retention.

REMARKS: Impact results in excess of 10 G's. Assembly exhibited undesirable column failure. Unsatisfactory rebound characteristics. See Strip Chart #30 for specifics.

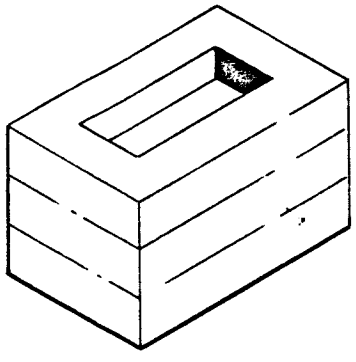
TEST #30



DESCRIPTION: 2 9" by 12" open cell hard polyurethane blocks with 3" by 6" cavities assembled as shown with wire retention only.

REMARKS: Impact results in excess of 10 G's. Assembly exhibited undesirable column failure. Unsatisfactory rebound characteristics. See Strip Chart #31 for specifics.

TEST #31

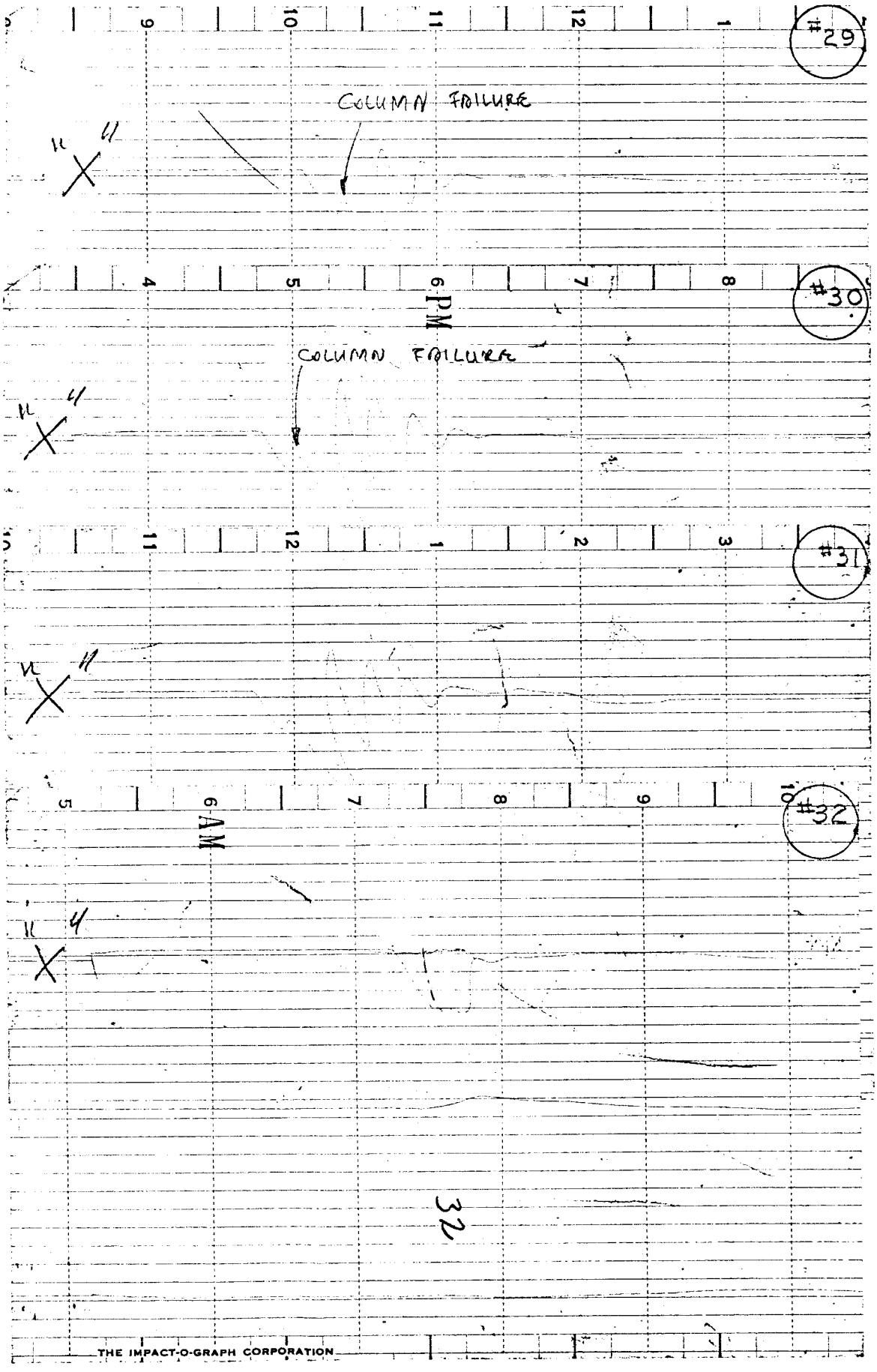


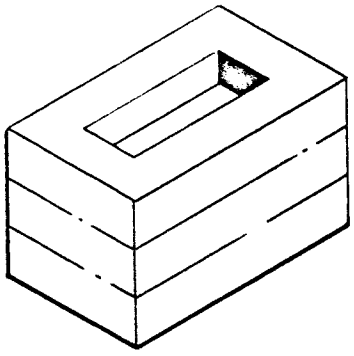
DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities, hardness as shown. Total stack height 12".

Soft
Hard
Hard

REMARKS: Satisfactory impact results (approximately 10 G's), however, stacked height of the test configuration and its size are not conducive to use as a shock mitigation device for this application. Adaptation of this method has promising potential.

TEST #32


#29
COLUMN FAILURE
#30
PM
COLUMN FAILURE
#31
#32
AM
32
THE IMPACT-O-GRAPH CORPORATION



Hard
Hard
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell hard polyurethane with 3" by 6" cavities. Total stack height 12".

REMARKS: Impact results slightly in excess of 10 G's with indications of collapsing column. Rebound characteristics marginal. See Strip Chart #33 for specifics.

TEST #33

Hard
Hard
Hard

Configuration Same as Above

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell hard polyurethane with 3" by 6" cavities. Total stack height 12".

REMARKS: Impact results slightly in excess of 10 G's with indications of collapsing column. Rebound characteristics marginal. See Strip Chart #34 for specifics.

TEST #34

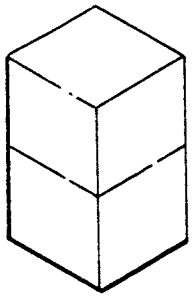
Hard
Hard
Hard

Configuration Same as Above

DESCRIPTION: 3 layers of 3-1/2" thick 9" by 12" open cell hard polyurethane with 3" by 6" cavities. Total stack height 12".

REMARKS: Impact results slightly in excess of 10 G's with indications of collapsing column. Rebound characteristics marginal. See Strip Chart #35 for specifics.

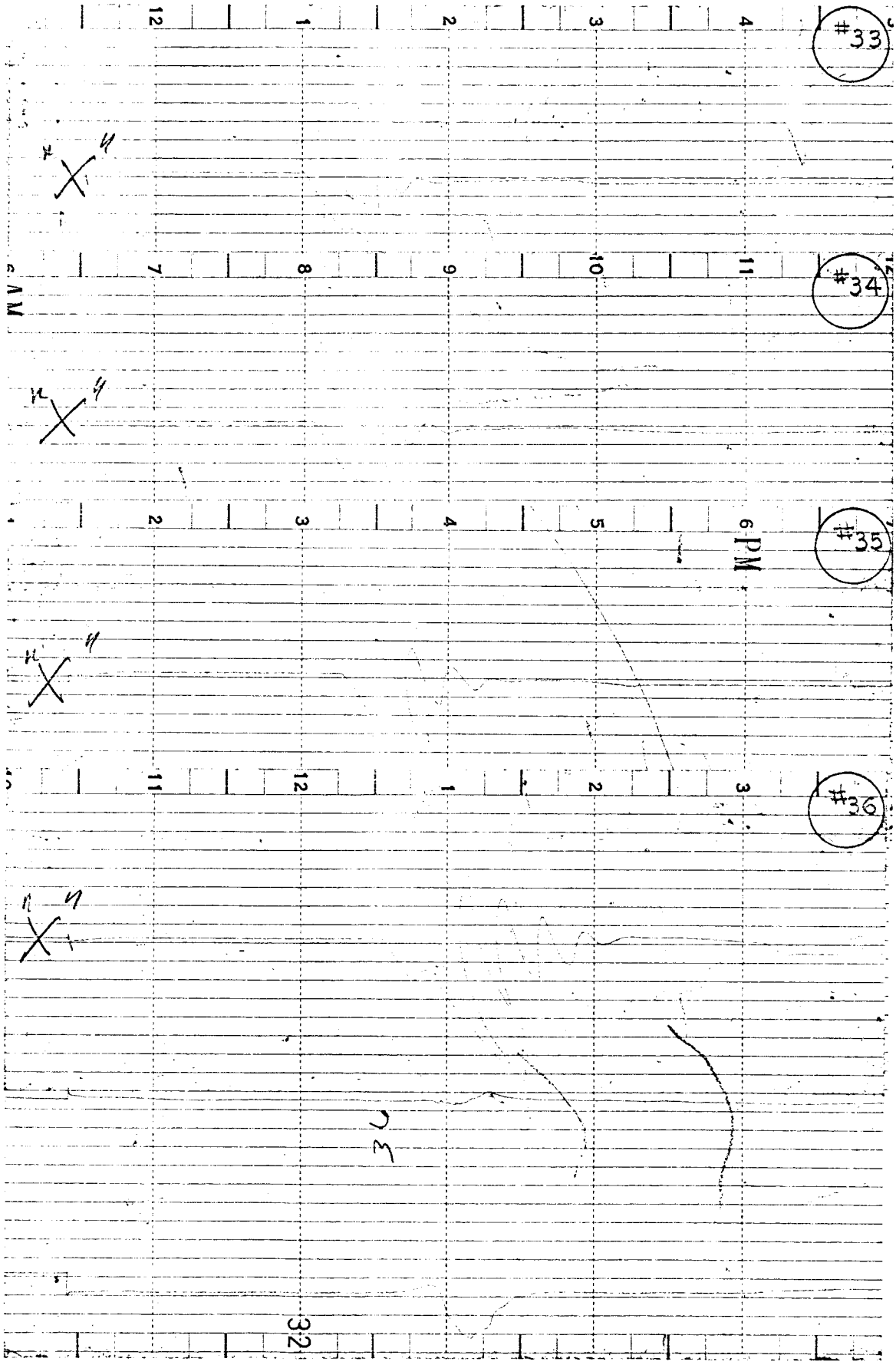
TEST #35

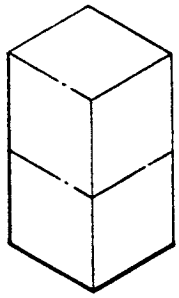


DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density).

REMARKS: Impact results considerably in excess of 10 G's. Indications of collapsing column. Undesirable rebound characteristics. See Strip Chart #36 for specifics.

TEST #36


#33
#34
#35
#36
AM
PM
12
1
2
3
4
7
8
9
10
11
2
3
4
5
6
11
12
1
2
3
32



DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density).

REMARKS: Impact results considerably in excess of 10 G's. Indications of collapsing column. Undesirable rebound characteristics. See Strip Chart #37 for specifics.

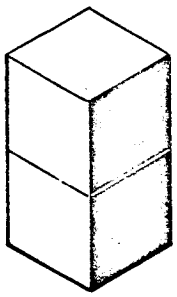
TEST #37

Configuration Same as Above

DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density).

REMARKS: Impact results considerably in excess of 10 G's. Indications of collapsing column. Undesirable rebound characteristics. See Strip Chart #38 for specifics.

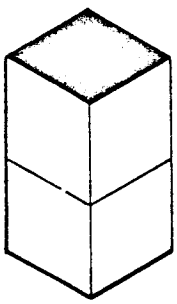
TEST #38



DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density). All outside exposed surfaces semi-sealed with 1 coat paint.

REMARKS: Impact results considerably in excess of 10 G's. Indications of collapsing column. Undesirable rebound characteristics. See Strip Chart #39 for specifics.

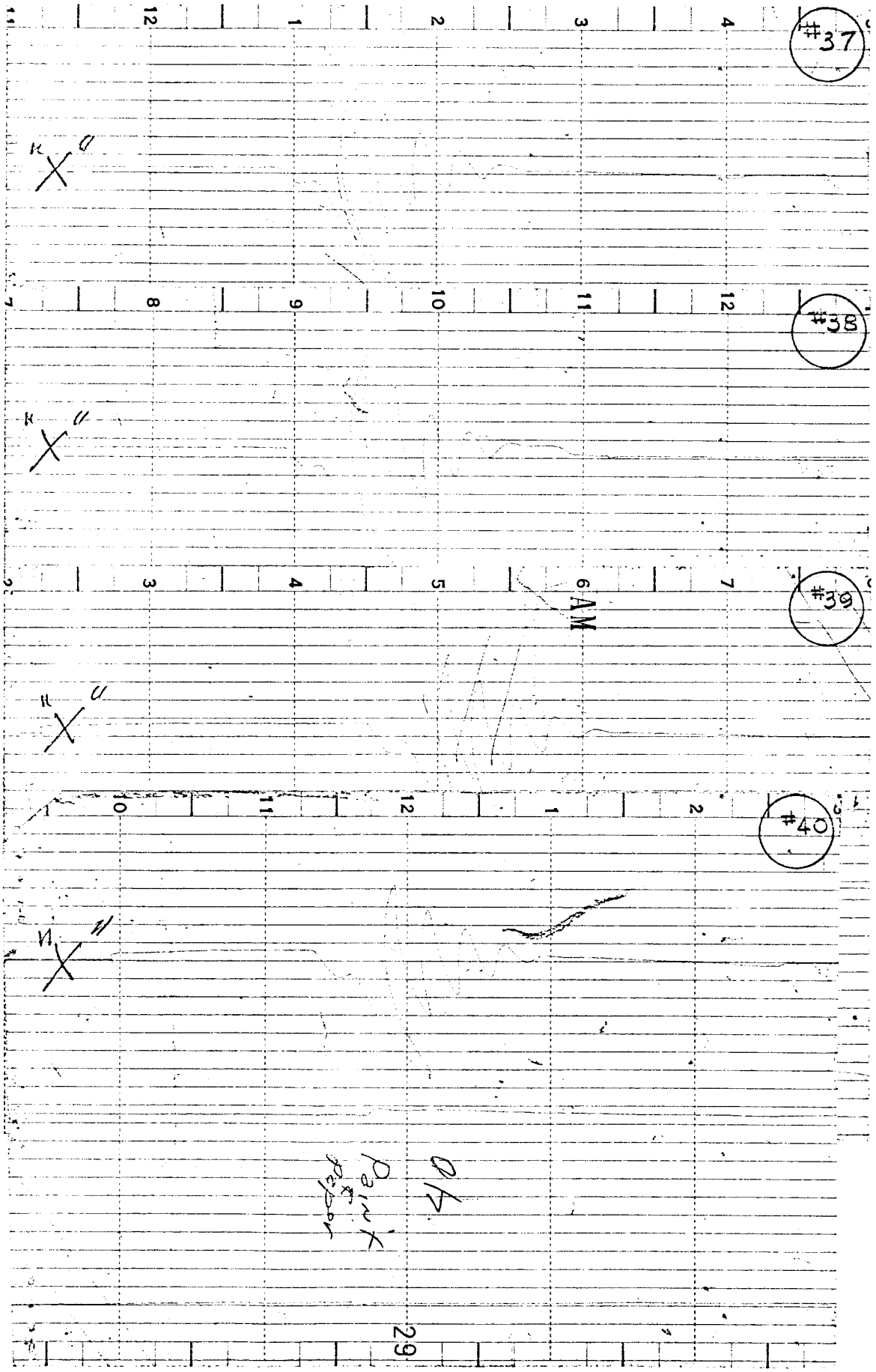
TEST #39



DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density). All vertical surfaces sealed with adhesive applied kraft paper.

REMARKS: Impact results considerably in excess of 10 G's. Indications of collapsing column. Undesirable rebound characteristics. See Strip Chart #40 for specifics.

TEST #40


#37
#38
#39
#40
AM
29

DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density). All outside exposed surfaces semi-sealed with 2 coats paint.

REMARKS: Good impact characteristics (less than 10 G's), however, indications of collapsing column should be improved upon. Rebound characteristics excellent.

TEST #41

Configuration Same as Above

DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density). All outside exposed surfaces semi-sealed with 2 coats paint. Rerun of Test #41 above with fractured painted surfaces.

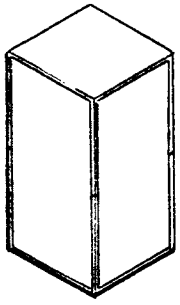
REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound. TEST #42

Configuration Same as Above

DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density). All outside exposed surfaces semi-sealed with 2 coats paint. Repeat of Test #42 above.

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

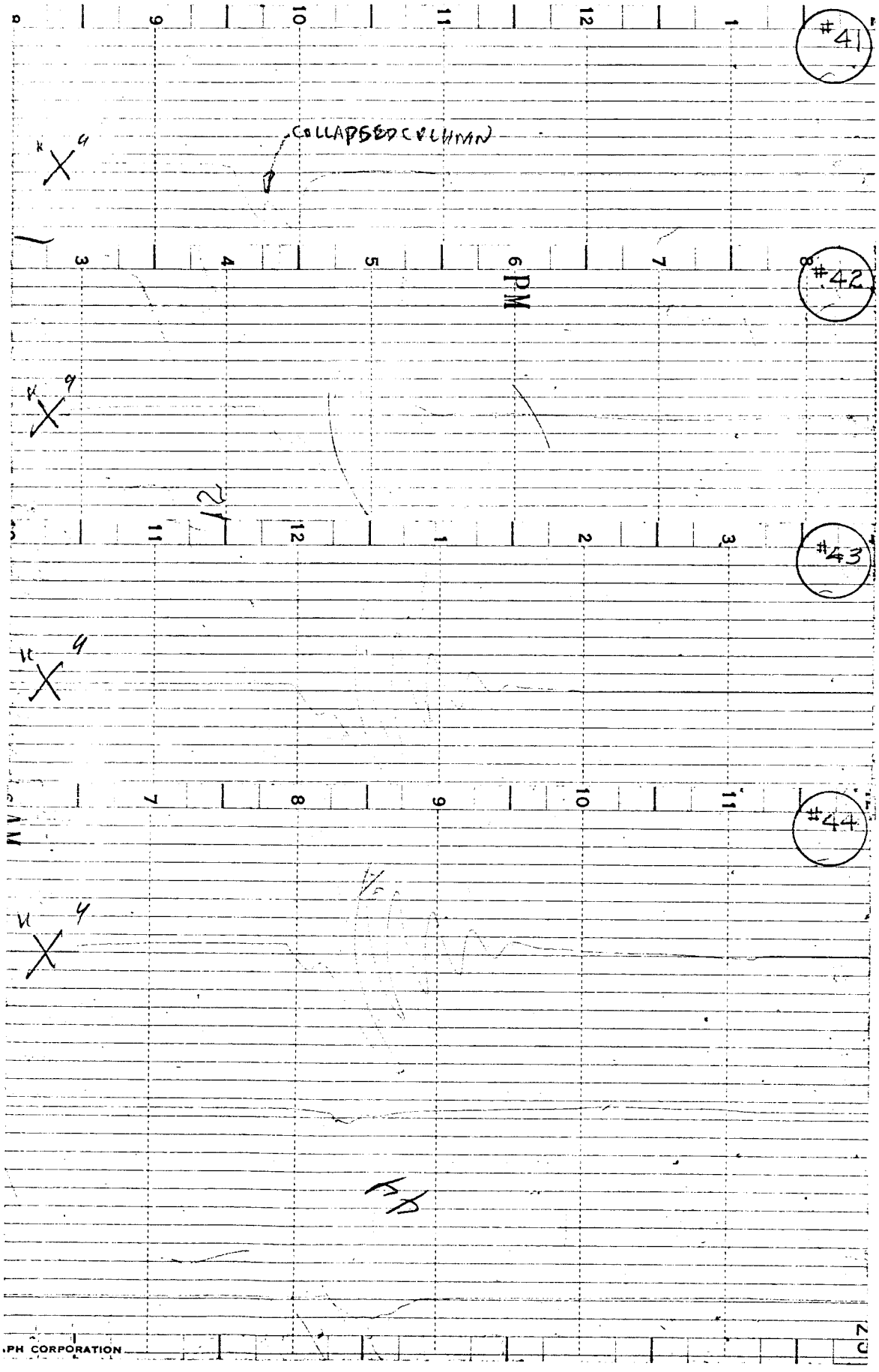
TEST #43

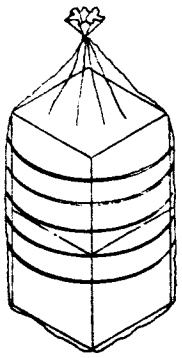


DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density), with polyurethane sheet attached to all exposed surfaces with adhesive.

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

TEST #44


#41
COLLAPSED COLUMN
#42
6 PM
#43
#44
PH CORPORATION



DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density), with loosely attached polyurethane sheet around the blocks restrained with elastic bands.

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

TEST #45

DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density), with loosely attached polyurethane sheet around the blocks restrained with elastic bands.

Configuration Same as Above

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

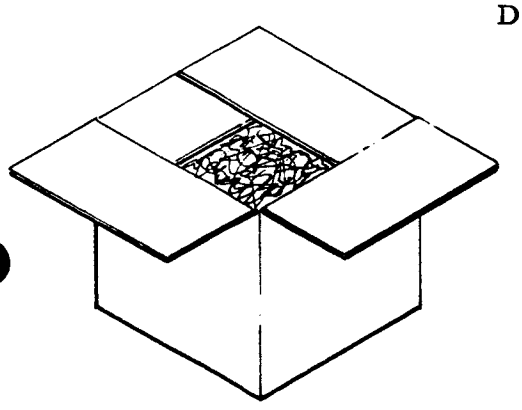
TEST #46

DESCRIPTION: 2 solid blocks 6" by 12" by 6" thick open cell hard polyurethane (2 pounds/cubic ft. density), with loosely attached polyurethane sheet around the blocks restrained with elastic bands.

Configuration Same as Above

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

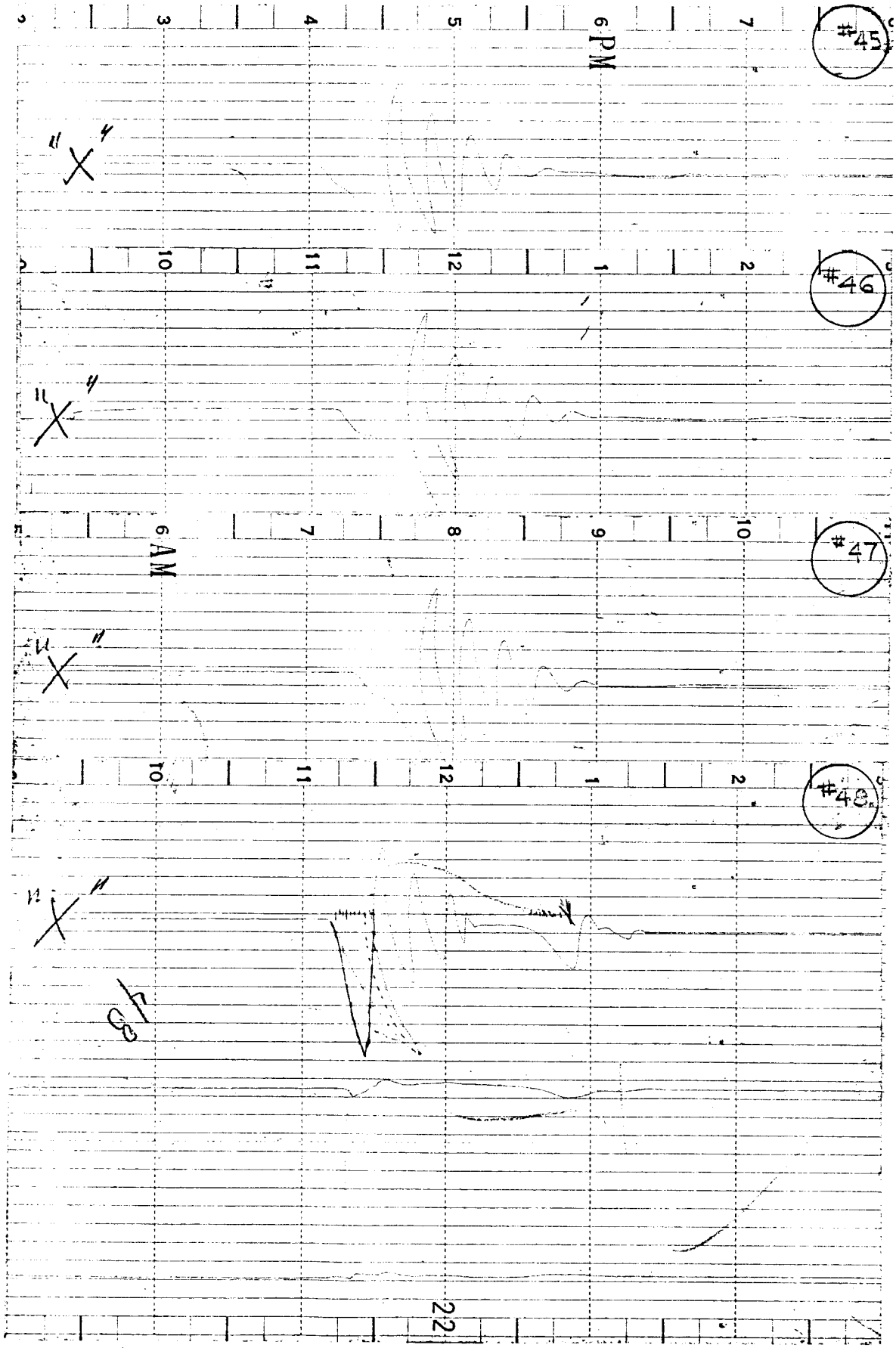
TEST #47

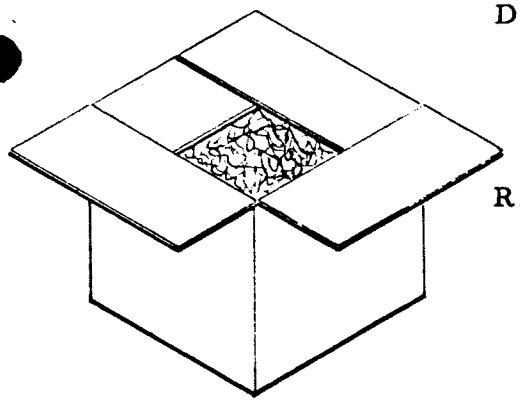


DESCRIPTION: 9" by 9" by 9" high cardboard assembly, styrofoam strip filled.

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

TEST #48

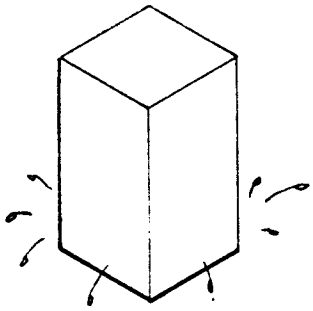

#45
6 PM
#46
#47
6 AM
#48
22



DESCRIPTION: 9" by 9" by 19" high cardboard assembly, styrofoam strip filled.

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

TEST #49

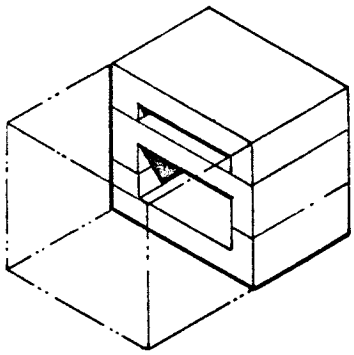


DESCRIPTION: 1, 6" by 6" by 12" high open cell hard polyurethane block (2 pounds/ cubic ft. density), water impregnated.

REMARKS: Indications of collapsing column and peaking of impact exceeding 10 G's by a considerable margin. Very undesirable rebound characteristics.

TEST #50

Soft
Soft
Hard

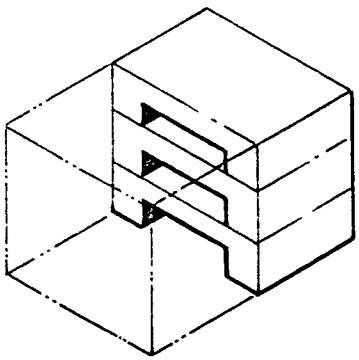


DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities. Hardness as shown. Stack arrangement as shown. Total stack height 12".

REMARKS: Impact results in excess of 10 G's with unsatisfactory rebound characteristics. See Strip Chart #51 for specifics.

TEST #51

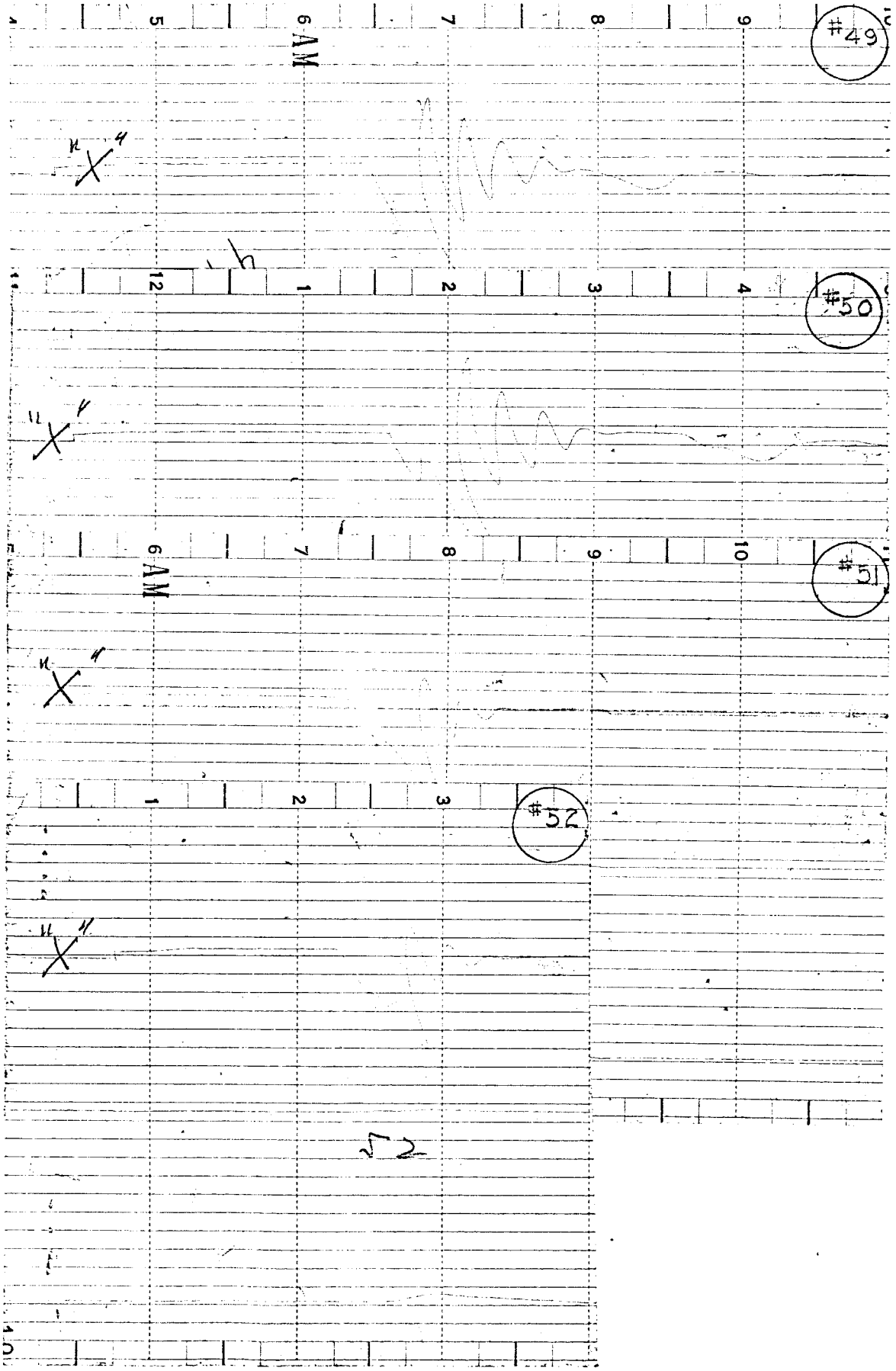
Soft
Soft
Hard

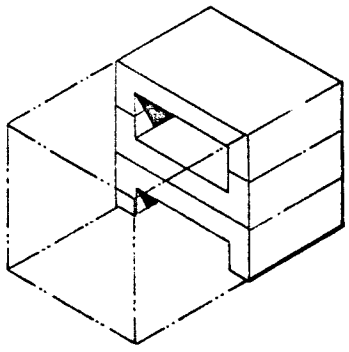


DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities. Hardness as shown. Stack arrangement as shown.

REMARKS: Impact results in excess of 10 G's with unsatisfactory rebound characteristics. See Strip Chart #52 for specifics.

TEST #52


#49
#50
#51
#52
6 AM
6 AM

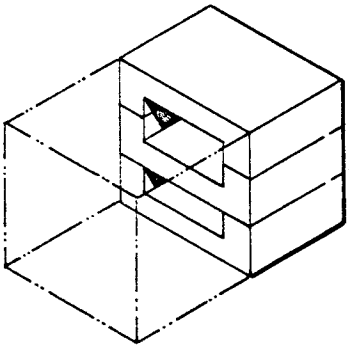


Soft
Soft
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities. Hardness as shown. Stack arrangement as shown.

REMARKS: Impact results in excess of 10 G's with unsatisfactory rebound characteristics. See Strip Chart #53 for specifics.

TEST #53

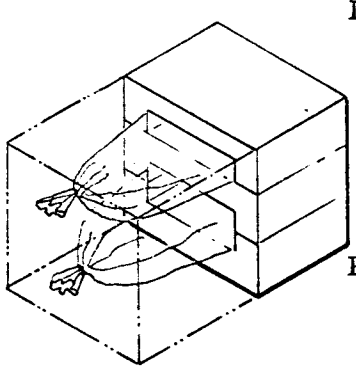


Soft
Soft
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities. Hardness as shown. Stack arrangement as shown.

REMARKS: Impact results in excess of 10 G's with unsatisfactory rebound characteristics. See Strip Chart #54 for specifics.

TEST #54

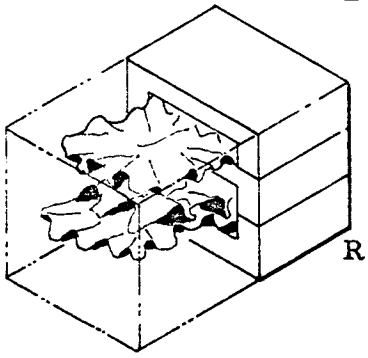


Soft
Soft
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities. Cavities contain air filled polyethylene bags as shown. Hardness as shown. Stack arrangement as shown.

REMARKS: Impact results in excess of 10 G's with unsatisfactory rebound characteristics. See Strip Chart #55 for specifics.

TEST #55

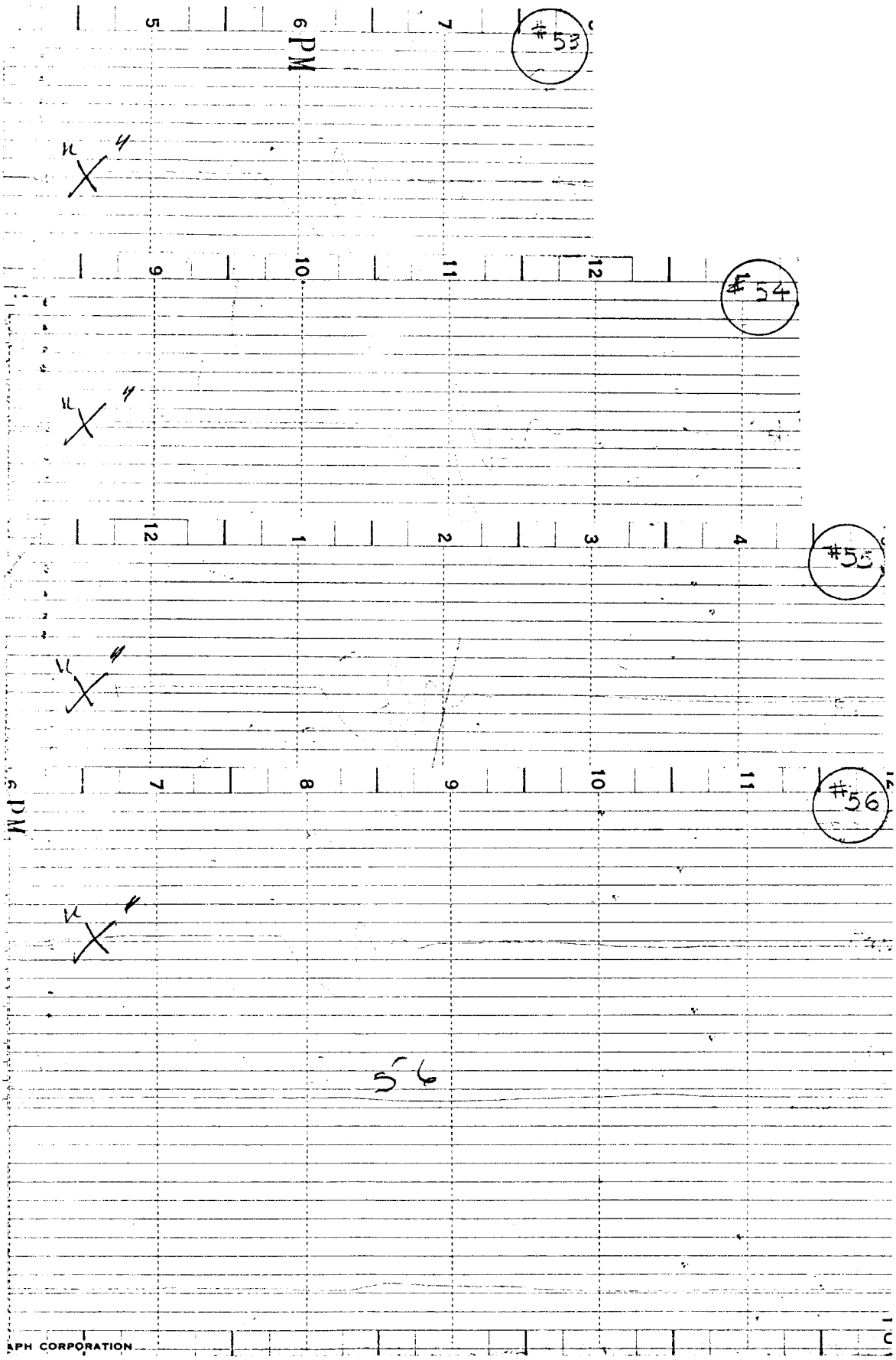


Soft
Soft
Hard

DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities. Cavities filled with loose wadded polyethylene sheet as shown. Hardness as shown. Stack arrangement as shown.

REMARKS: Impact results in excess of 10 G's, however, this configuration is an improvement over previous five tests. Rebound characteristics are also improved.

TEST #56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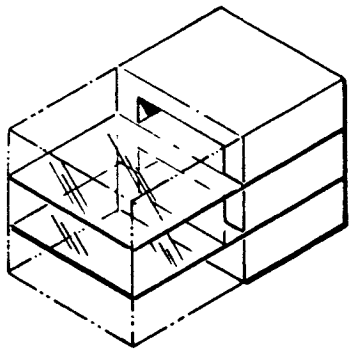
56
APH CORPORATION

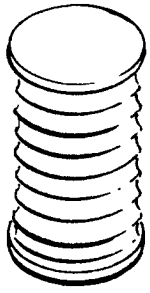
Soft
Soft
Hard



DESCRIPTION: 3 layers of 4" thick 9" by 12" open cell polyurethane with 3" by 6" cavities. Interface of cavities covered with polyethylene sheet as shown. Hardness as shown. Stack arrangement as shown.

REMARKS: Impact results in excess of 10 G's, however, this configuration is an improvement over previous five tests. Rebound characteristics are also improved.

TEST #57



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end. Total height 10".

REMARKS: Impact results slightly in excess of 10 G's with good dissipation rate, however, assembly exhibited unstable, non-repeatable characteristics on the rebound side of the impact curve.

TEST #58

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end. Total height 10".

REMARKS: Impact results slightly in excess of 10 G's with good dissipation rate, however, assembly exhibited unstable, non-repeatable characteristics on the rebound side of the impact curve.

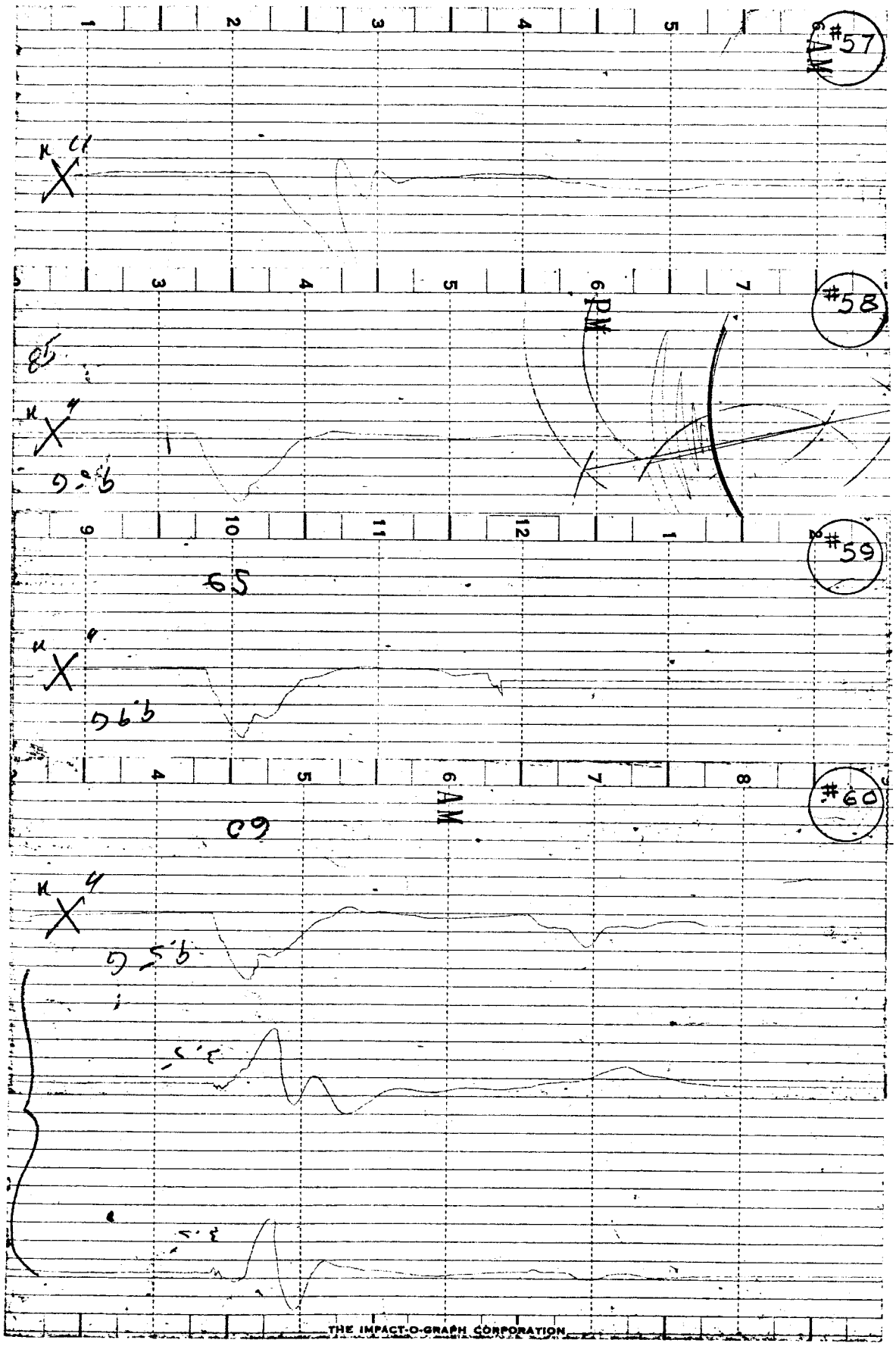
TEST #59

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end. Total height 10".

REMARKS: Impact results slightly in excess of 10 G's with good dissipation rate, however, assembly exhibited unstable, non-repeatable characteristics on the rebound side of the impact curve.

TEST #60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6 PM
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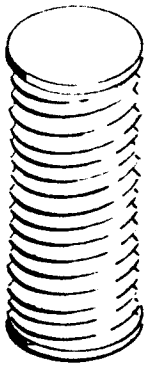
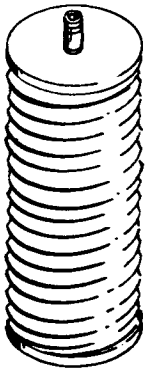
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter light duct material covering helical wound spring, rubber impregnated, overall assembly height 11", both ends capped.

REMARKS: Impact results in excess of 10 G's. Good dissipation rate characteristics, however, assembly exhibited unstable, non-repeatable characteristics on the rebound side of the impact curve.

TEST #61



DESCRIPTION: 6" diameter light duct material covering helical wound spring, rubber impregnated, overall assembly height 11", both ends capped, and one end outfitted with 1/8" pipe fitting as a rough air metering device.

REMARKS: Impact results in excess of 10 G's. Good dissipation rate characteristics, however, assembly exhibited unstable, non-repeatable characteristics on the rebound side of the impact curve.

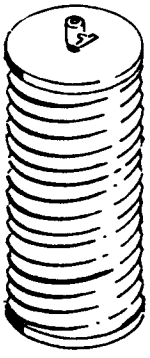
TEST #62

Configuration Same as Above

DESCRIPTION: 6" diameter light duct material covering helical wound spring, rubber impregnated, overall assembly height 11", both ends capped, and one end outfitted with 1/8" pipe fitting as a rough air metering device.

REMARKS: Impact results in excess of 10 G's. Good dissipation rate characteristics, however, assembly exhibited unstable, non-repeatable characteristics on the rebound side of the impact curve.

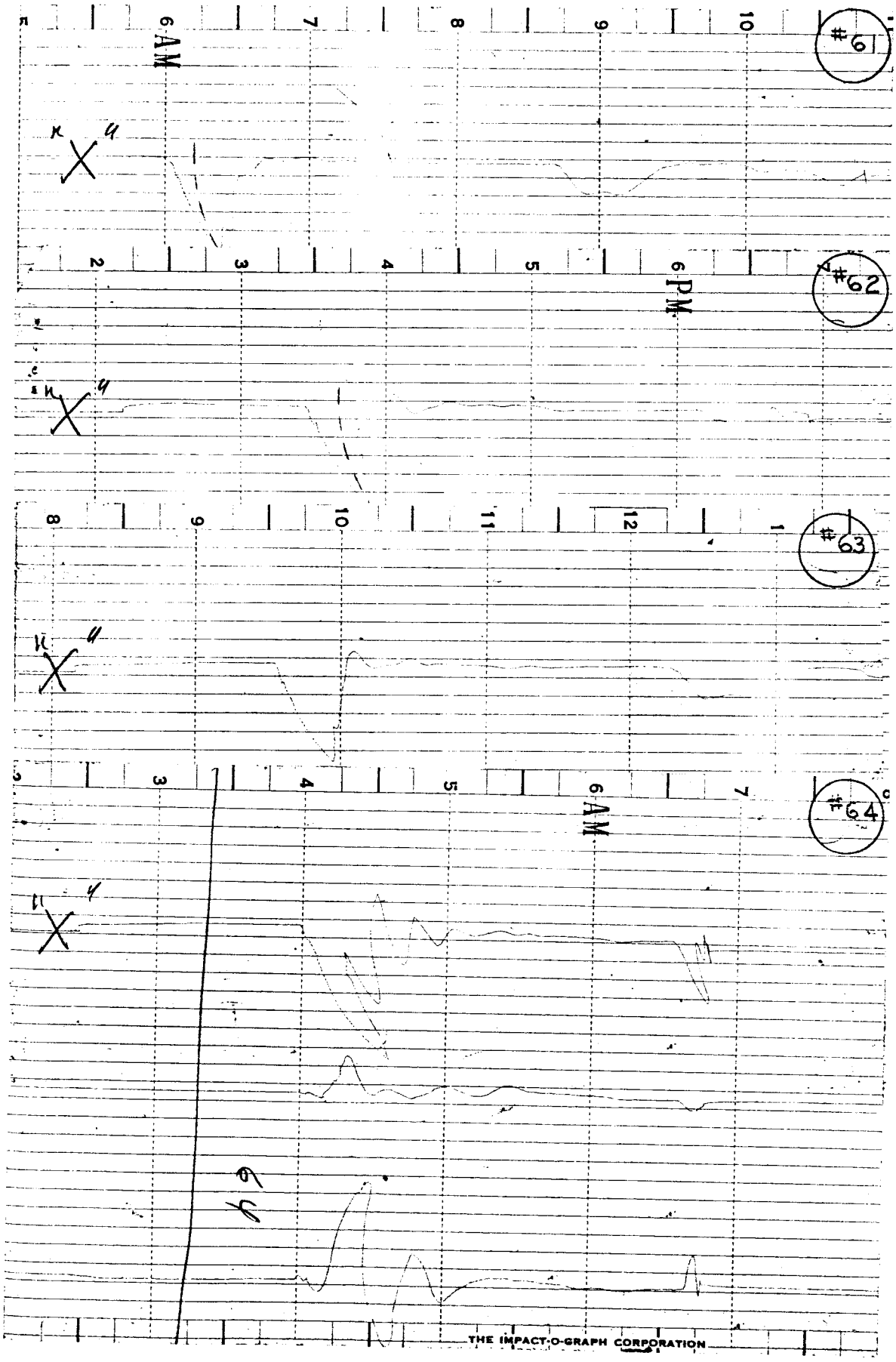
TEST #63



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end, and one end outfitted with a petcock to the half open position.

REMARKS: Impact considerably in excess of 10 G's. Dissipation rate undesirable. Rebound characteristics and stability totally undesirable.

TEST #64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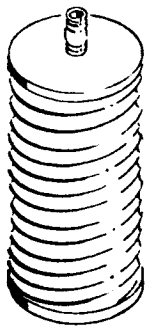
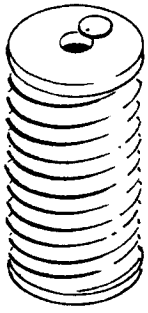
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end with 3/4" metered fitting at one end. Assembly height 11".

REMARKS: Impact in excess of 10 G's. Dissipation characteristics undesirable. Erratic rebound characteristics. Bad stability.

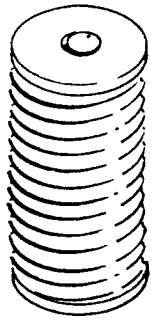
TEST #65



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with fully opened (1-1/16" diameter) gate type valve. Assembly height 11".

REMARKS: Impact results considerably in excess of 10 G's. Indications of collapsing column. Extremely undesirable rebound characteristics.

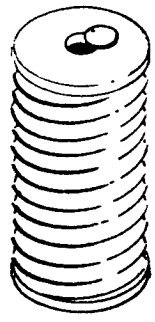
TEST #66



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end with fully closed (1-1/16" diameter) gate type valve. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Unstable dissipation. Indications of collapsing column. Undesirable rebound characteristics.

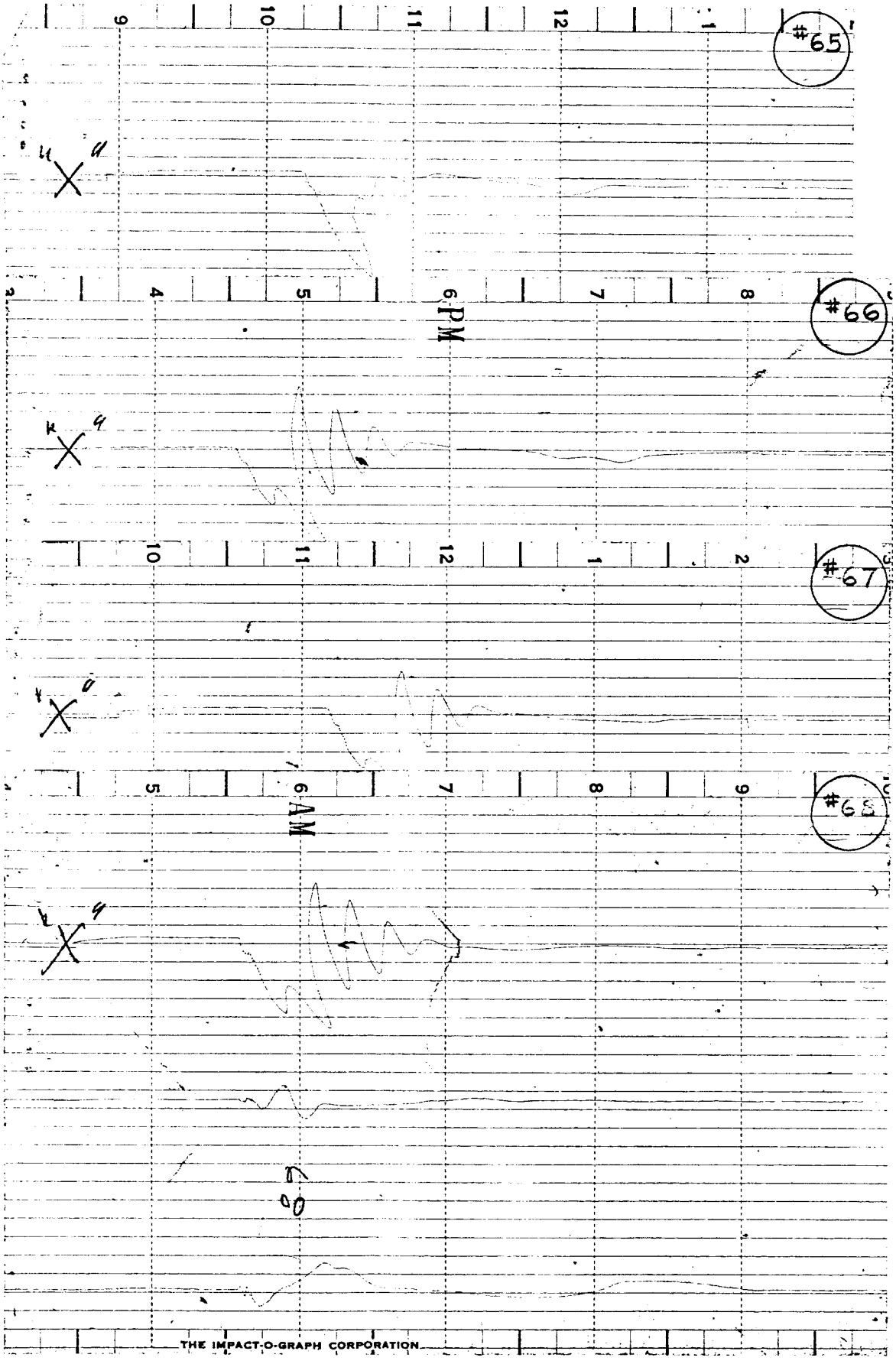
TEST #67



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 25% covered. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Very undesirable column characteristics. Indicated bad dissipation rate. Undesirable rebound characteristics.

TEST #68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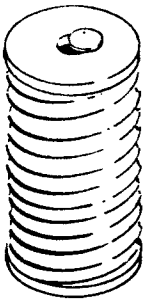
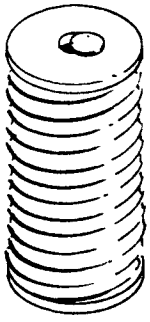
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 50% covered. Assembly height 11".

REMARKS: Impact results slightly in excess of 10 G's. Indications of desirable dissipation rate. Good energy dissipation indicated by straight line portion of recovery. Good rebound characteristics.

TEST #69



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Indications of collapsing column. Undesirable rebound characteristics.

TEST #70

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Undesirable dissipation characteristics. Extreme case of collapsing column. Bad rebound characteristics.

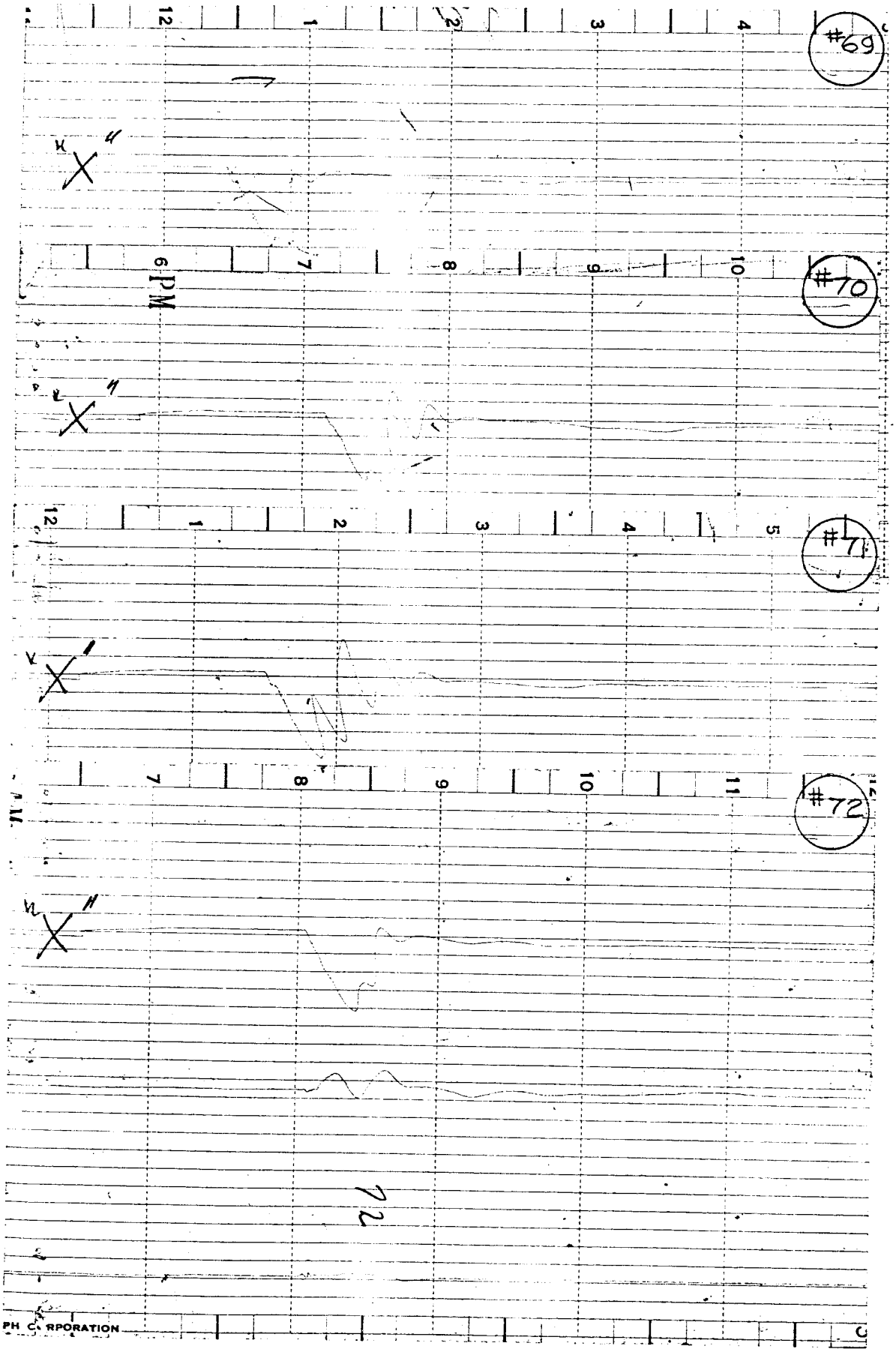
TEST #71

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Good dissipation rate. Bad recovery. Acceptable rebound characteristics.

TEST #72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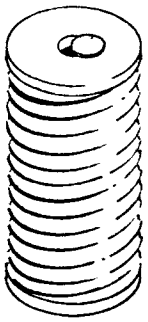


DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Good dissipation characteristics. Unstable indication at crest of indication. Excellent rebound characteristics.

TEST #73

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Instability indications. Marginal rebound characteristics.

TEST #74

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Impact results considerably in excess of 10 G's. Unstable dissipation characteristics. Totally unacceptable rebound characteristics.

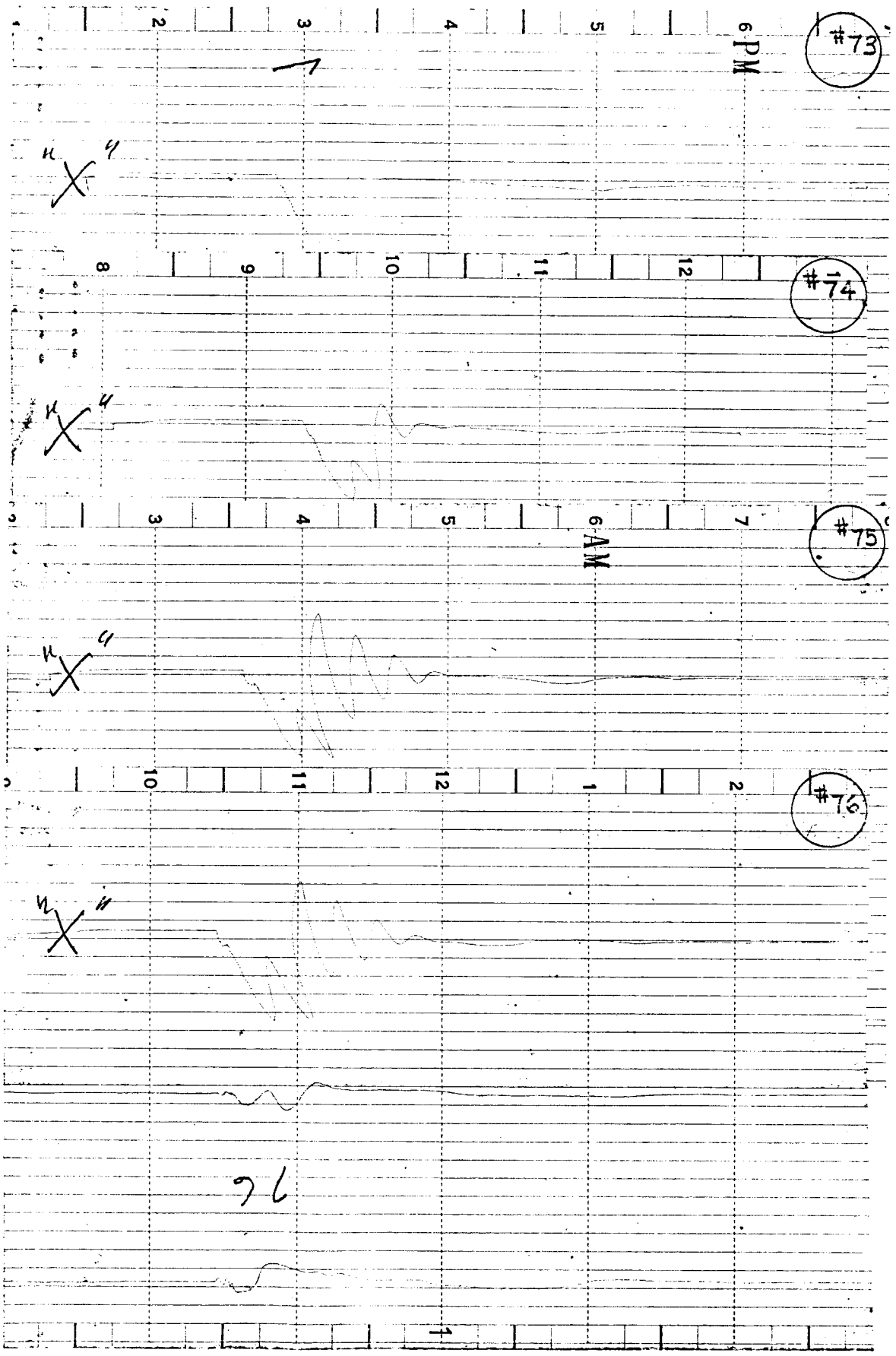
TEST #75

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Very unstable indications followed by very undesirable rebound characteristics.

TEST #76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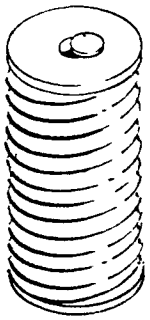
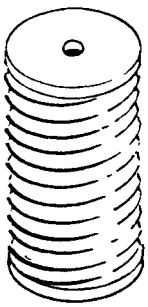


DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with gate valve (1-1/16" diameter), 75% covered. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Very unstable indications followed by very undesirable rebound characteristics.

TEST #77



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 3/4" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Spiked crest on curve. Marginal rebound characteristics.

TEST #78

Configuration Same as Above

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 3/4" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Spiked crest on curve. Marginal rebound characteristics.

TEST #79

Configuration Same as Above

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 7/8" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Dissipation characteristics unstable. Rebound characteristics totally unacceptable.

TEST #80

6 PM
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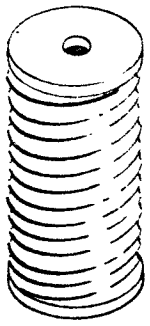
58



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 7/8" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Dissipation characteristics unstable. Rebound characteristics totally unacceptable.

TEST #81

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 13/16" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Very unstable characteristics. Undesirable rebound characteristics.

TEST #82

Configuration Same as Above

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 13/16" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Very unstable characteristics. Undesirable rebound characteristics.

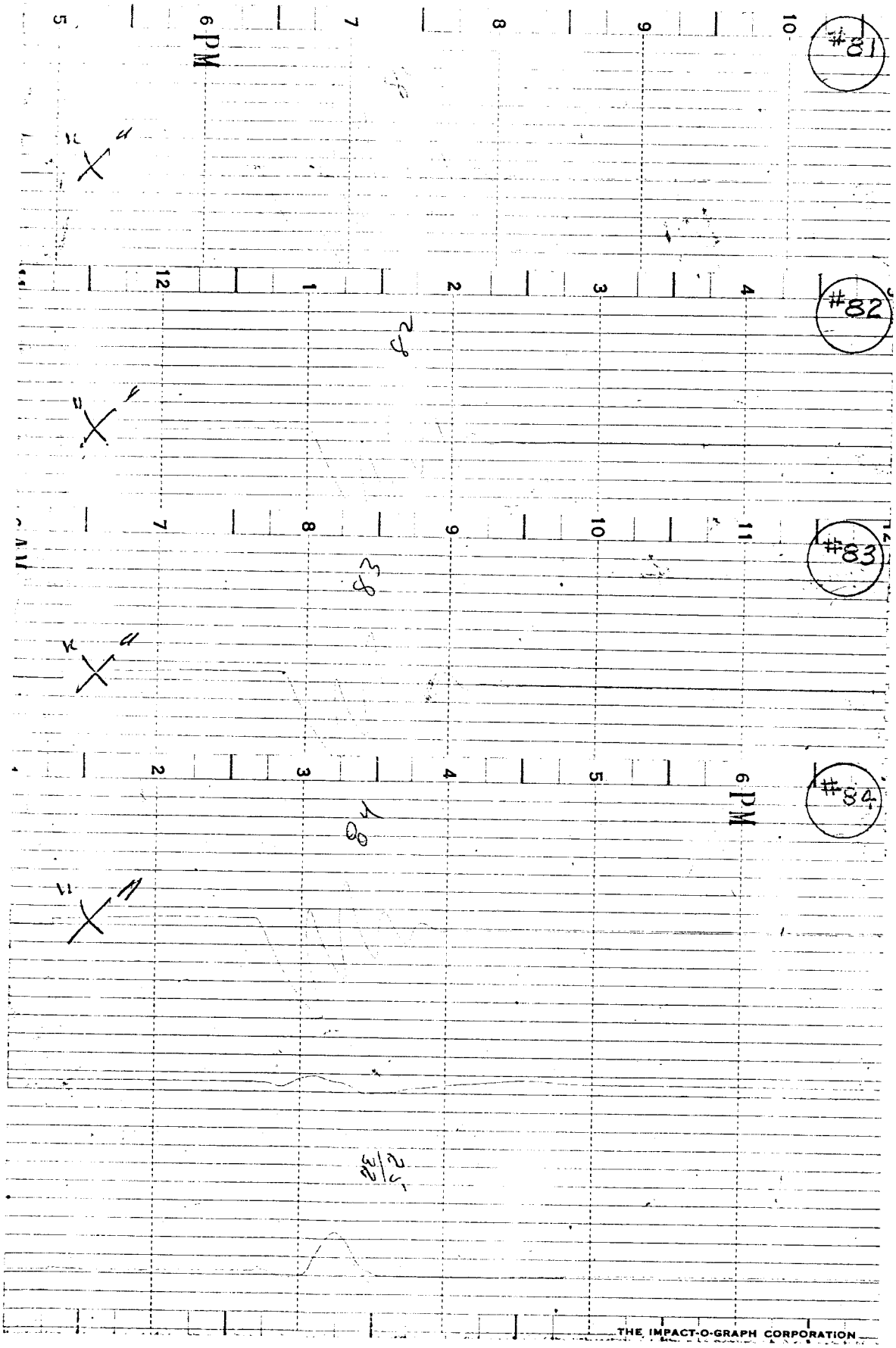
TEST #83

Configuration Same as Above

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 25/32" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Very unstable characteristics. Undesirable rebound characteristics.

TEST #84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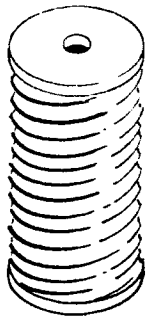
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 25/32" orifice. Assembly height 10".

REMARKS: Impact results considerably in excess of 10 G's. Very unstable characteristics. Undesirable rebound characteristics.

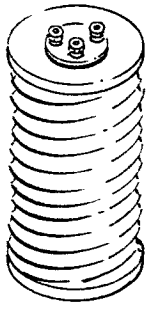
TEST #85

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound insert capped at each end and one end containing a 25/32" orifice. Assembly height 10".

Configuration Same as Above

REMARKS: Impact results in excess of 10 G's. Impact recovery appears to be unstable on the rebound part of the curve. Does not appear to be repeatable.

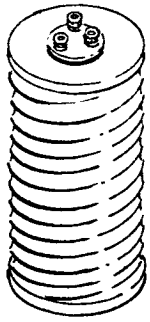
TEST #86



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with spring loaded check valve. Assembly height 11". Opening covered by check valve 25/32" diameter.

REMARKS: Impact results in excess of 10 G's. Unstable recovery. Undesirable rebound characteristics.

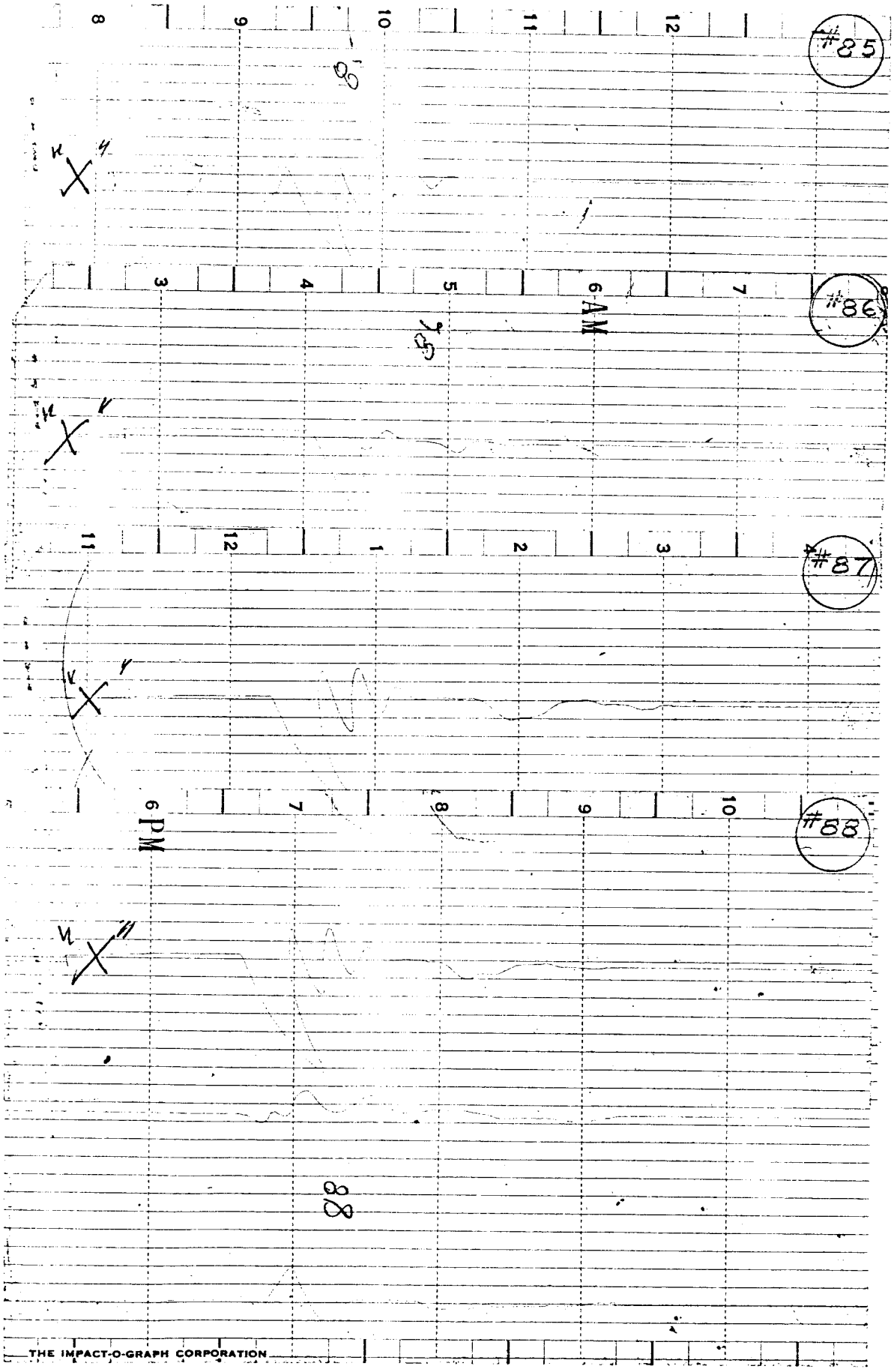
TEST #87



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with spring loaded check valve. Assembly height 11". Opening covered by check valve 25/32" diameter.

REMARKS: Impact results in excess of 10 G's. Unstable recovery. Undesirable rebound characteristics.

TEST #88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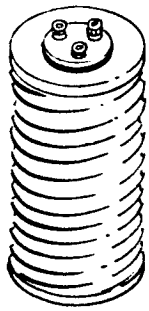
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with spring loaded check valve. Assembly height 11". Opening covered by check valve 25/32" diameter.

REMARKS: Impact results in excess of 10 G's. Unstable recovery. Undesirable rebound characteristics.

TEST #89

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with spring loaded check valve. Assembly height 11". Opening covered by check valve 1-1/16" diameter.

Configuration Same as Above

REMARKS: Impact results in excess of 10 G's. Bad recovery characteristics. Very undesirable characteristics(rebound).

TEST #90

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with spring loaded check valve. Assembly height 11". Opening covered by check valve 1-1/16" diameter.

Configuration Same as Above

REMARKS: Impact results in excess of 10 G's. Bad recovery characteristics. Very undesirable characteristics(rebound).

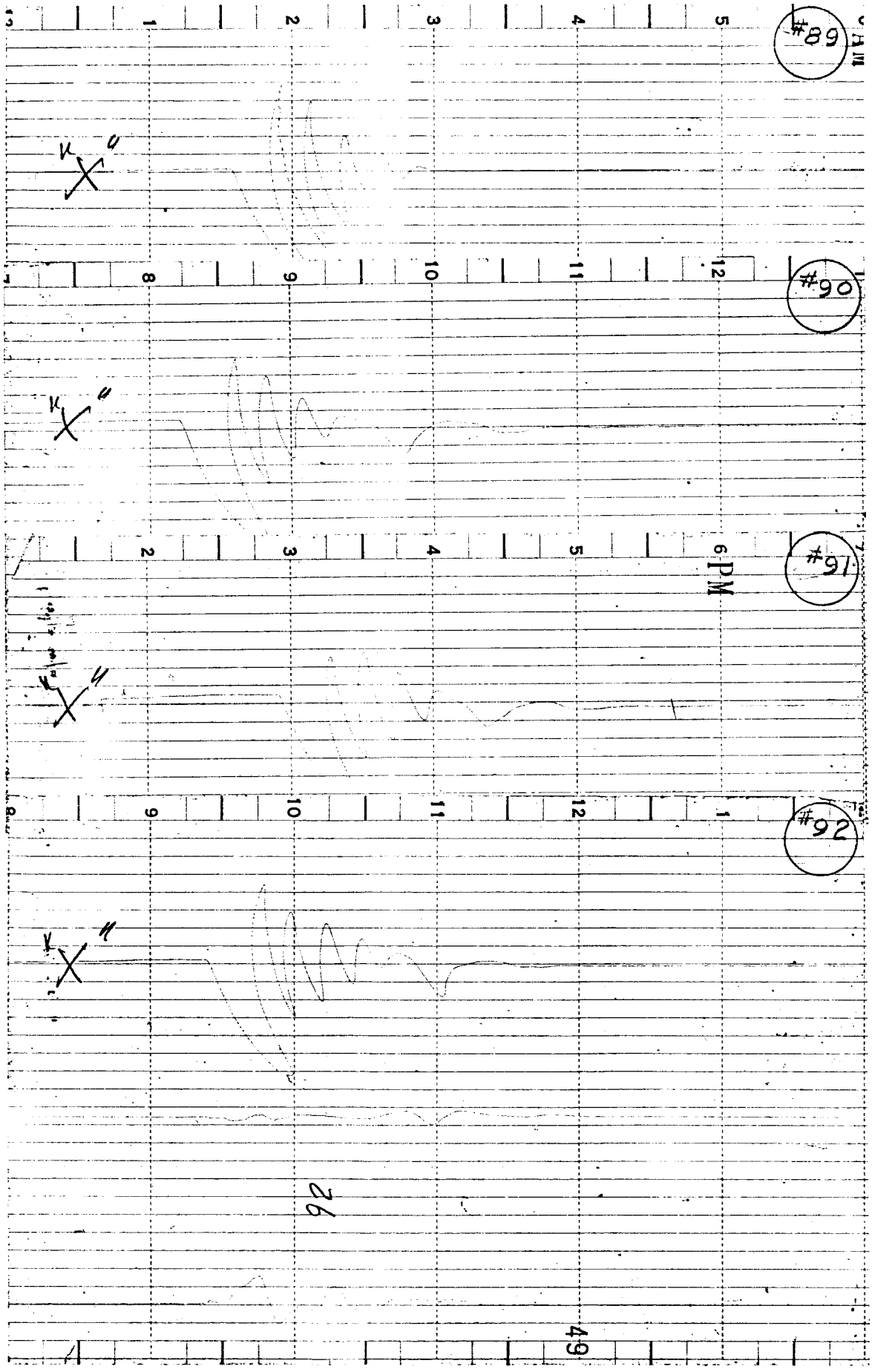
TEST #91

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with spring loaded check valve. Assembly height 11". Opening covered by check valve 13/16" diameter and valve 25% open.

Configuration Same as Above

REMARKS: Impact results in excess of 10 G's. Bad recovery characteristics. Very undesirable characteristics(rebound).

TEST #92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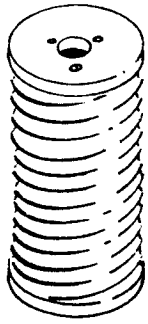


DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end. Valve completely removed. Orifice at one end 13/16" diameter. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Bad recovery characteristics. Very undesirable rebound characteristics.

TEST #93

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end. Valve completely removed. Orifice at one end 13/16" diameter. Assembly height 11".

REMARKS: Impact results in excess of 10 G's. Bad recovery characteristics. Very undesirable rebound characteristics.

TEST #94

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 27/32"diameter orifice. Check valve removed. Total assembly height 11".

REMARKS: Impact results in excess of 10 G's. Good recovery and rebound characteristics.

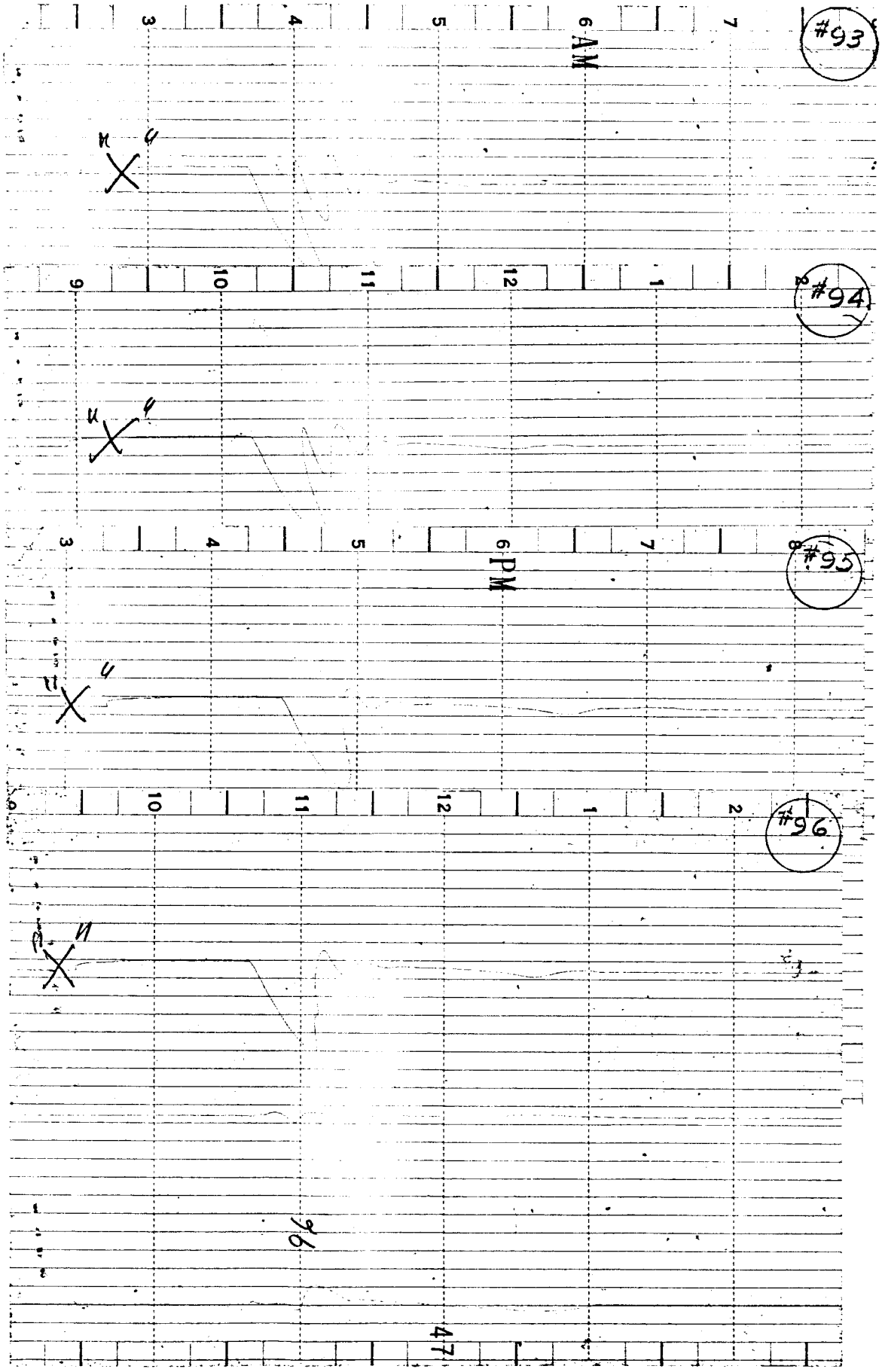
TEST #95

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 27/32" diameter orifice. Check valve removed. Total assembly height 11".

REMARKS: Impact results in excess of 10 G's. Good recovery and rebound characteristics.

TEST #96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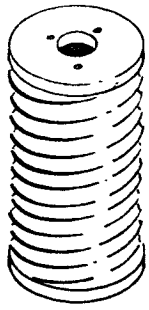


DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 7/8" diameter orifice. Check valve removed. Total assembly height 11".

REMARKS: Impact in excess of 10 G's. Indications of instability and bad rebound characteristics.

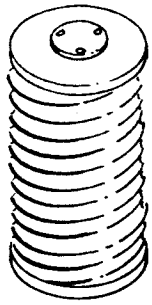
TEST #97

Configuration Same as Above

DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 7/8" diameter orifice. Check valve removed. Total assembly height 11".

REMARKS: Impact in excess of 10 G's. Indications of instability and bad rebound characteristics.

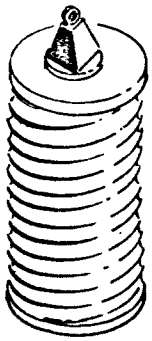
TEST #98



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 7/8" diameter orifice. Valve plate loosely layed over orifice opening (no retention).

REMARKS: Impact in excess of 10 G's. Unstable dissipation and rebound characteristics.

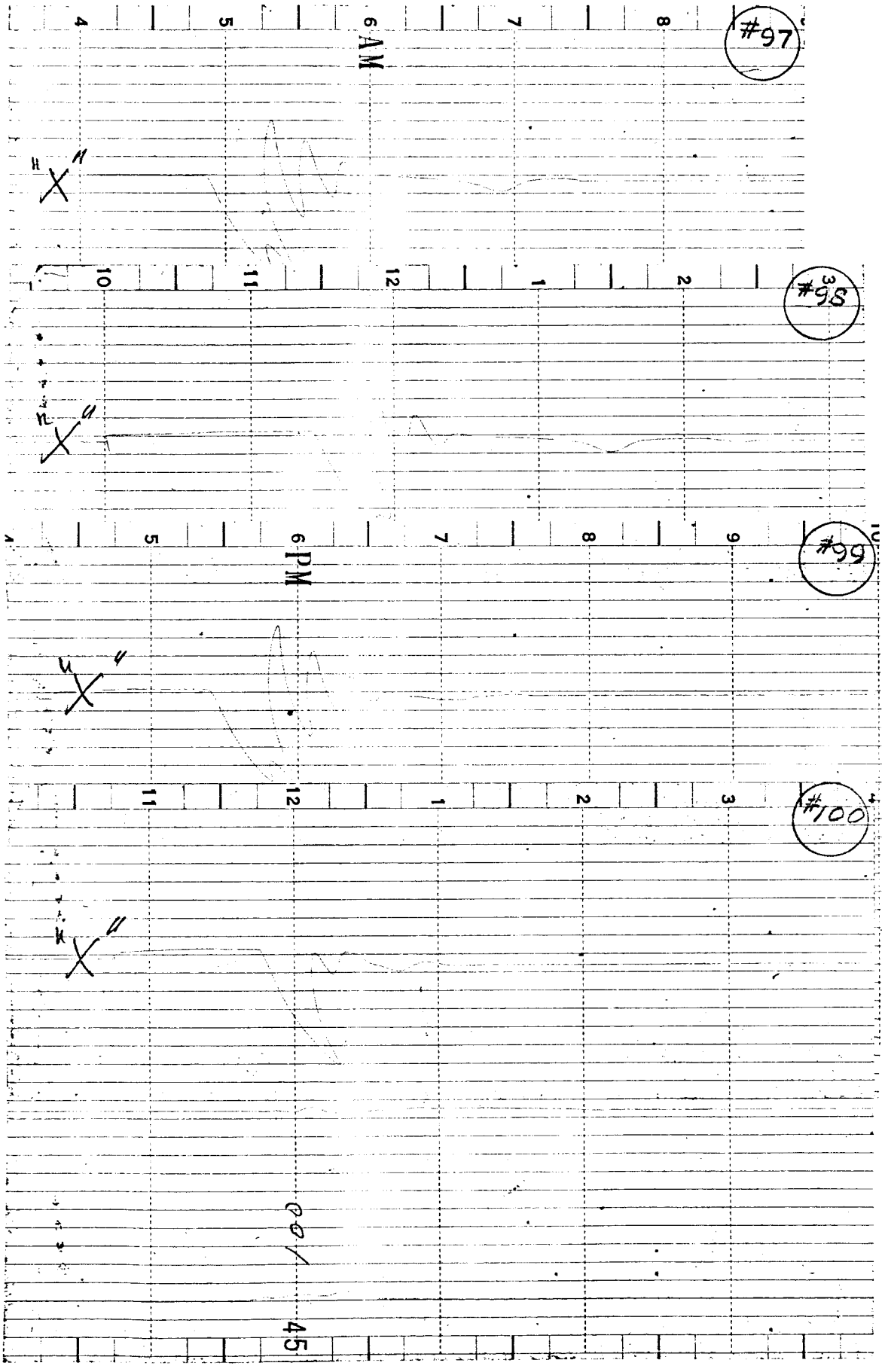
TEST #99



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 7/8" diameter orifice. Valve plate loosely layed over orifice opening but restrained by a 5 oz. weight.

REMARKS: Impact in excess of 10 G's. Indications of unstable rebound characteristics.

TEST #100


#97
6 AM
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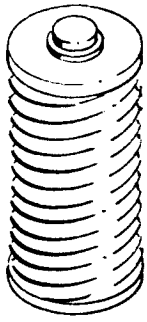
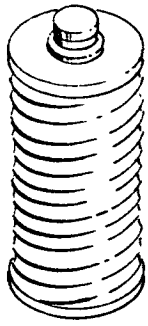
6 PM
#100
45



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 7/8" diameter orifice. Valve plate loosely layed over orifice opening but restrained by a 7 oz. weight.

REMARKS: Impact in excess of 10 G's. Indications of unstable rebound characteristics.

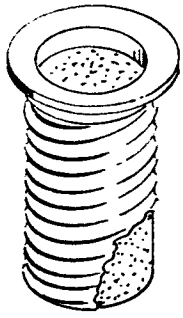
TEST #101



DESCRIPTION: 6" diameter heavy duty vinyl covered duct material with helical wire wound frame capped at each end and one end outfitted with a 7/8" diameter orifice. Valve plate loosely layed over orifice opening but restrained by a 9 oz. weight.

REMARKS: Impact in excess of 10 G's. Indications of unstable rebound characteristics.

TEST #102



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, opposite end of ducting mounted to flange. Total assembly packed with polyurethane foam material. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

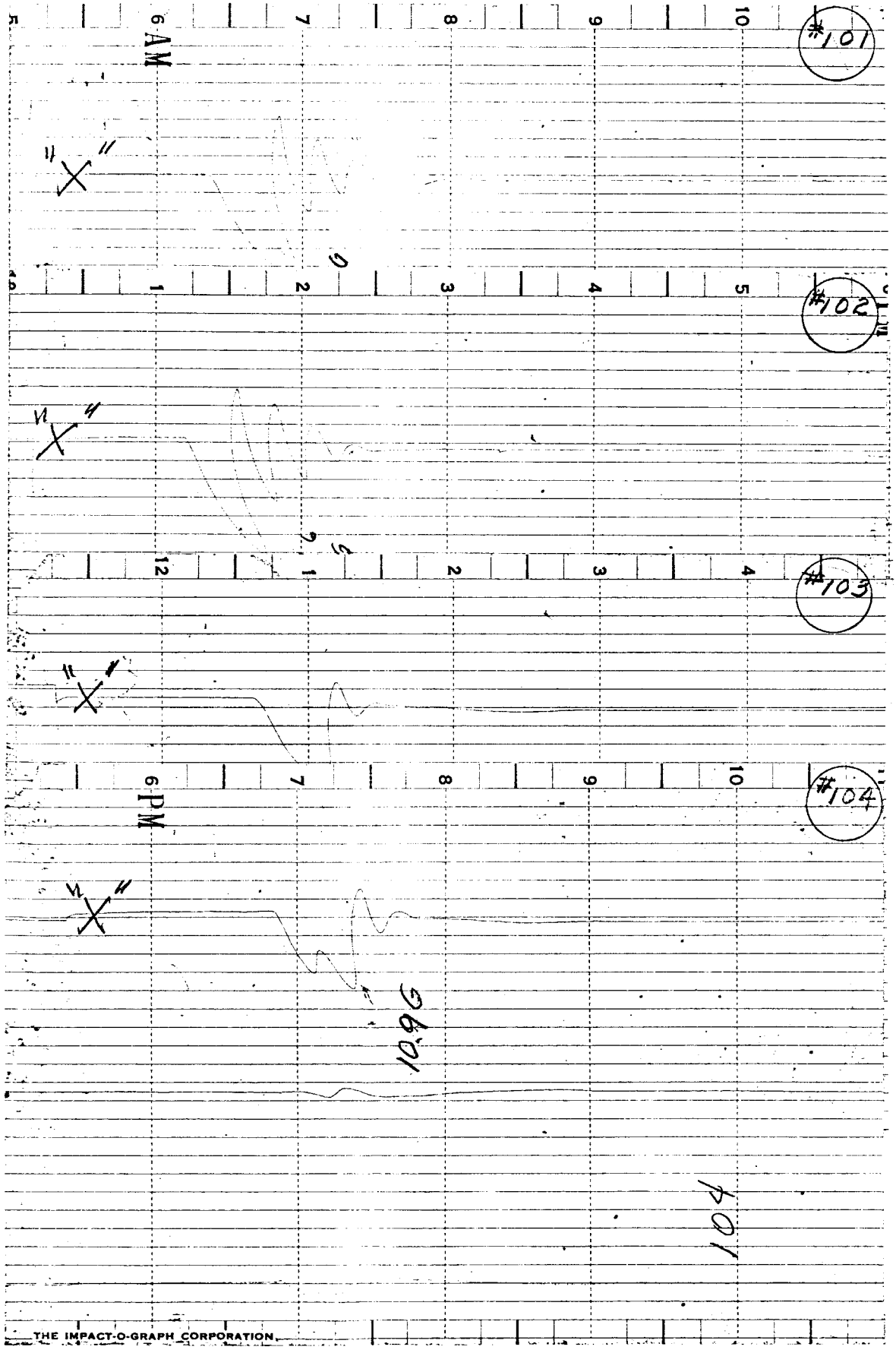
REMARKS: Impact peak 10.2 G's. Very good dissipation characteristics with acceptable rebound characteristics. TEST #103

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, opposite end of ducting mounted to flange. Total assembly packed with polyurethane foam material. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

Configuration Same as Above

REMARKS: Indications of column failure. Peak impact 10.9 G's with marginal rebound characteristics.

 TEST #104


6 AM
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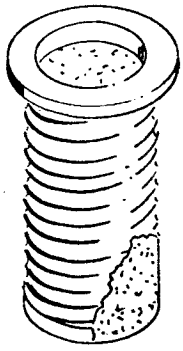
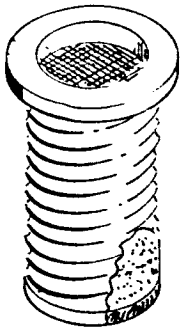
401
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, opposite end of ducting mounted to flange. Total assembly packed with polyurethane foam material. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

REMARKS: Impact peak 10.2 G's. Very good dissipation characteristics with acceptable rebound characteristics. TEST #105



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, opposite end of ducting mounted to flange. Total assembly packed with polyurethane foam material retained by 16 mesh screen. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

REMARKS: Acceptable dissipation characteristics. Impact slightly exceeded 10 G's. Marginal rebound characteristics. TEST #106

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, opposite end of ducting mounted to flange. Total assembly packed with polyurethane foam material retained by 16 mesh screen. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

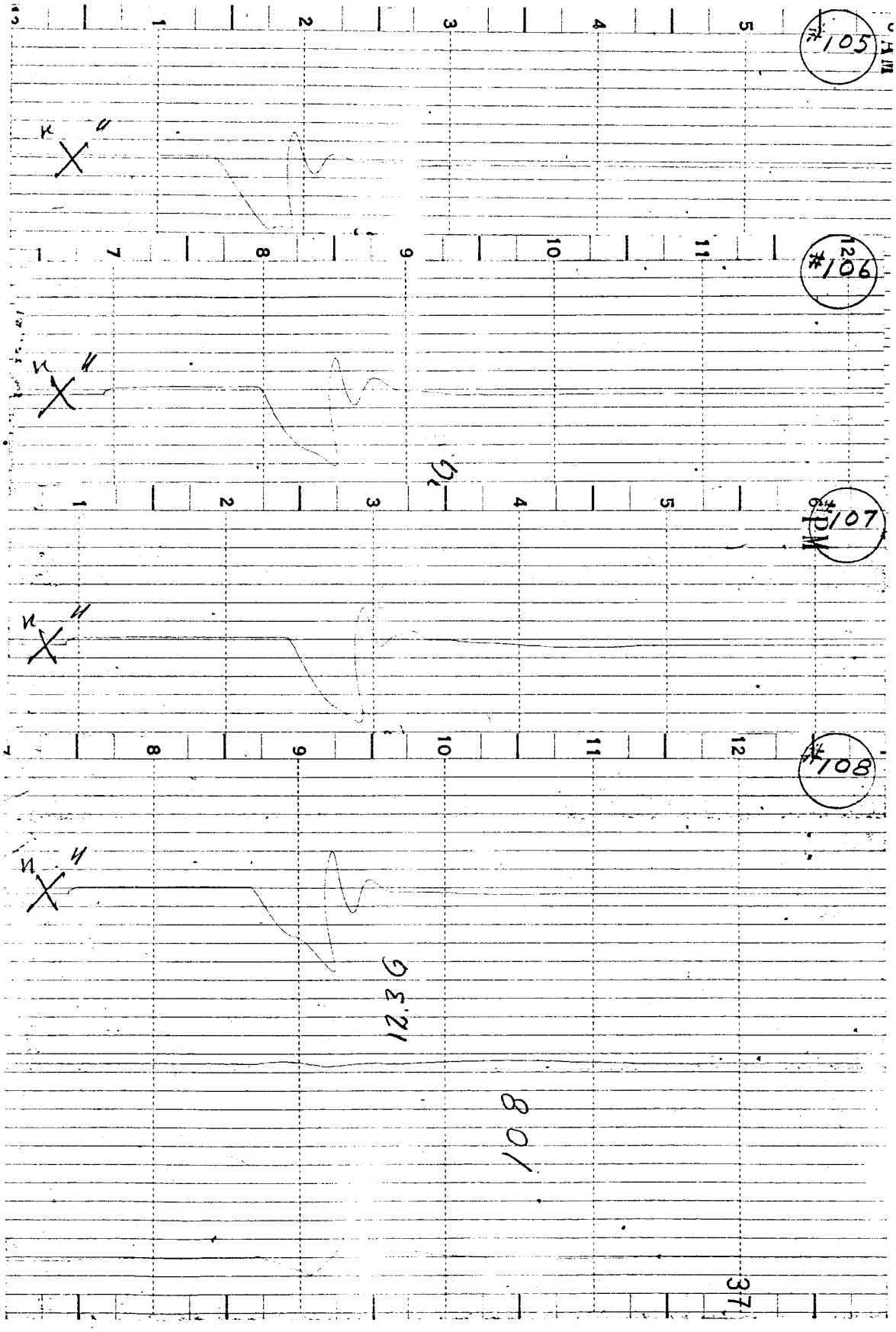
Configuration Same as Above

REMARKS: Acceptable dissipation characteristics. Impact slightly exceeded 10 G's. Marginal rebound characteristics. TEST #107

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame, one end of ducting mounted to flange. Total assembly packed with polyurethane foam material retained by 16 mesh screen. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

Configuration Same as Above

REMARKS: Acceptable dissipation characteristics. Impact slightly exceeded 10 G's. Marginal rebound characteristics. TEST #108


#105
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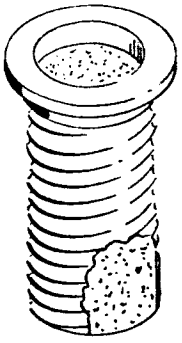
#108
12.3 G
8 01
37



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame, one end of ducting mounted to flange. Total assembly packed with polyurethane foam material retained by 16 mesh screen. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

REMARKS: Acceptable dissipation characteristics. Impact slightly exceeded 10 G's. Marginal rebound characteristics.

TEST #109

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame, one end of ducting mounted to flange. Total assembly packed with polyurethane foam material retained by 16 mesh screen. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

Configuration Same as Above

REMARKS: Acceptable dissipation characteristics. Impact slightly exceeded 10 G's. Marginal rebound characteristics.

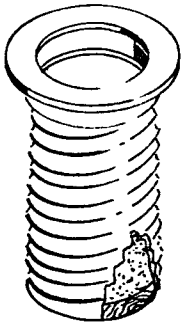
TEST #110

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, opposite end of ducting mounted to flange. Total assembly packed with polyurethane foam material retained by 16 mesh screen. Total assembly height 13". Polyurethane foam filler compacted to approximately 12".

Configuration Same as Above

REMARKS: Acceptable dissipation characteristics. Impact slightly exceeded 10 G's. Marginal rebound characteristics.

TEST #111

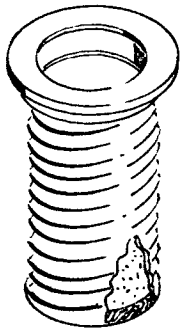


DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with a 5-1/4" opening. Total duct assembly height 12-1/2". Polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Very good shock dissipation characteristics. Impact 10.2 G's. Good rebound characteristics.

TEST #112

#109
#110
#111
#112
6 AM
6 PM
34



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with a 5-1/4" opening. Total duct assembly height 12-1/2". Polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Excellent shock dissipation characteristics. Peak impact was 9.5 G's. Very good rebound characteristics.

TEST #113

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with a 5-1/4" opening. Total duct assembly height 10-1/2". Polyurethane foam filler compressed to 9-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics, however, impact was 12.9 G's with marginal rebound characteristics.

TEST #114

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-1/2". Polyurethane foam filler compressed to 9-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics, however, impact was 12.9 G's with marginal rebound characteristics.

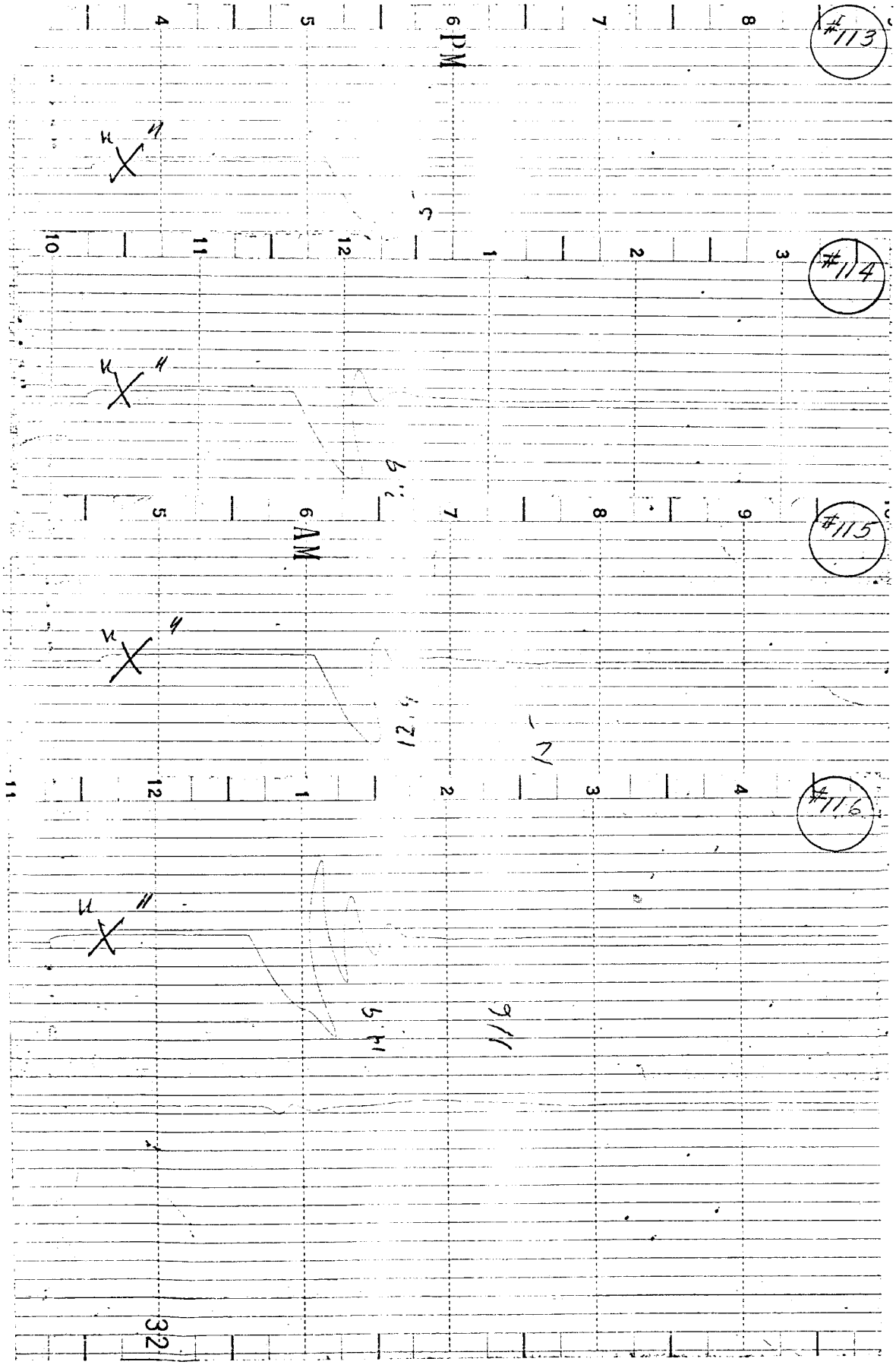
TEST #115

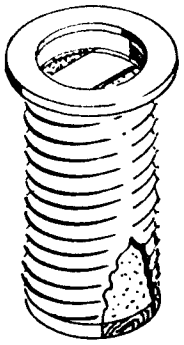
DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-1/2". Polyurethane foam filler compressed to 8-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Shock dissipation characteristics marginal. Impact considerably in excess of 10 G's. Rebound characteristics very undesirable.

TEST #116


#113
6 PM
#114
#115
6 AM
#116
32



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-1/2". Polyurethane foam filler 10-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Shock dissipation characteristics marginal. Impact considerably in excess of 10 G's. Rebound characteristics very undesirable.

TEST #117

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-1/2". Polyurethane foam filler 10-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Shock dissipation characteristics marginal. Impact considerably in excess of 10 G's. Rebound characteristics very undesirable.

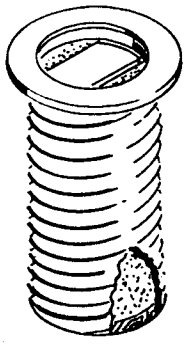
TEST #118

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-1/2". Polyurethane foam filler 10-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Shock dissipation characteristics marginal. Impact considerably in excess of 10 G's. Rebound characteristics very undesirable.

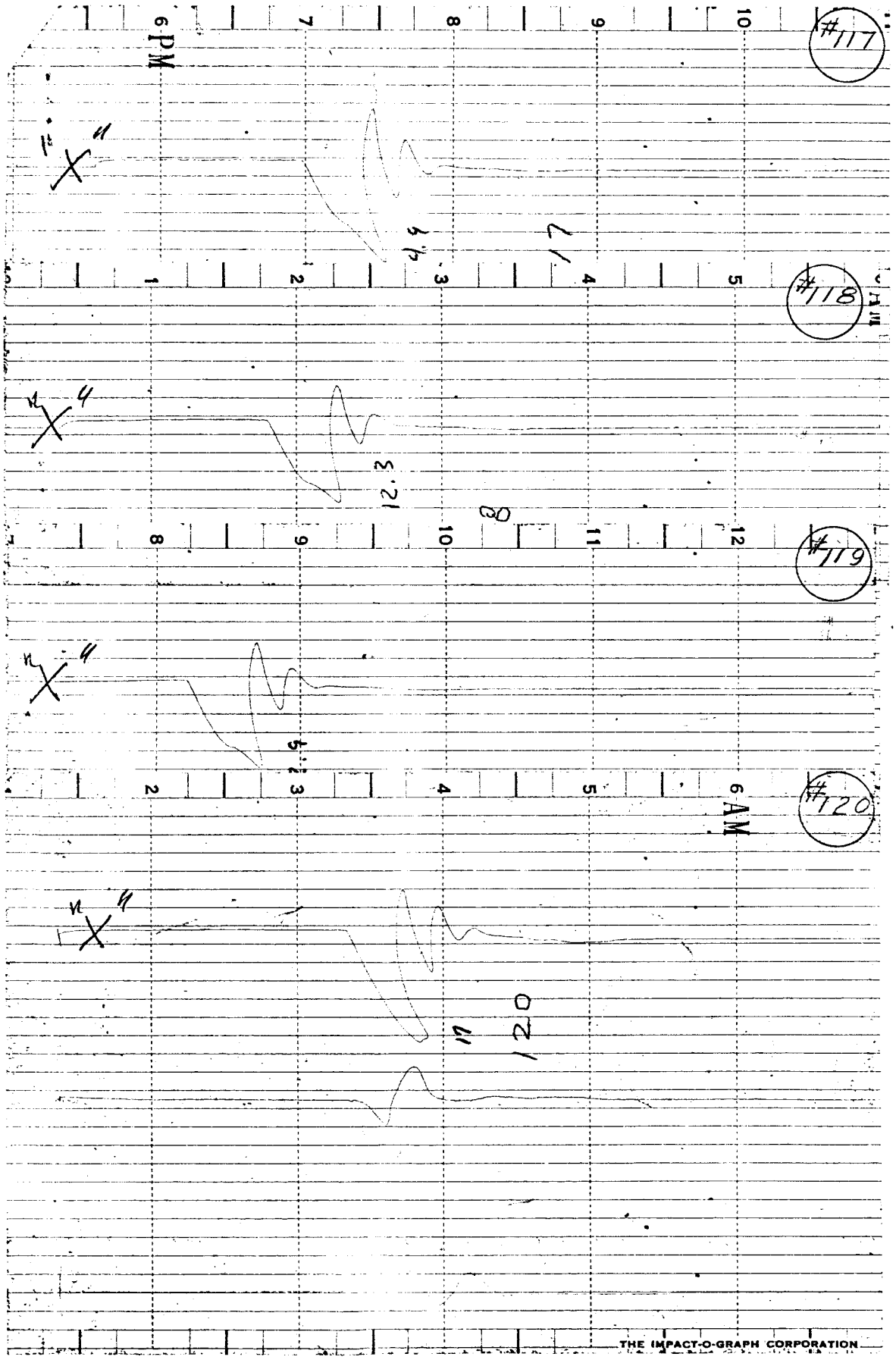
TEST #119



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-1/2". Polyurethane foam filler 10-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Shock dissipation characteristics marginal. Impact considerably in excess of 10 G's. Rebound characteristics very undesirable.

TEST #120


#117
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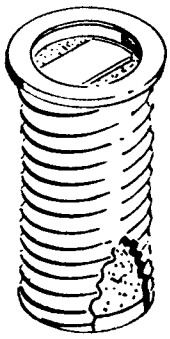
6 AM
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-3/4". Polyurethane foam filler compressed to 9-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Marginal shock dissipation characteristics. Impact considerably in excess of 10 G's. Undesirable or unrepeatable rebound characteristics.

TEST #121

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 10-3/4". Polyurethane foam filler compressed to 9-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact considerably in excess of 10 G's. Undesirable or unrepeatable rebound characteristics.

TEST #122

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact considerably in excess of 10 G's. Undesirable or unrepeatable rebound characteristics.

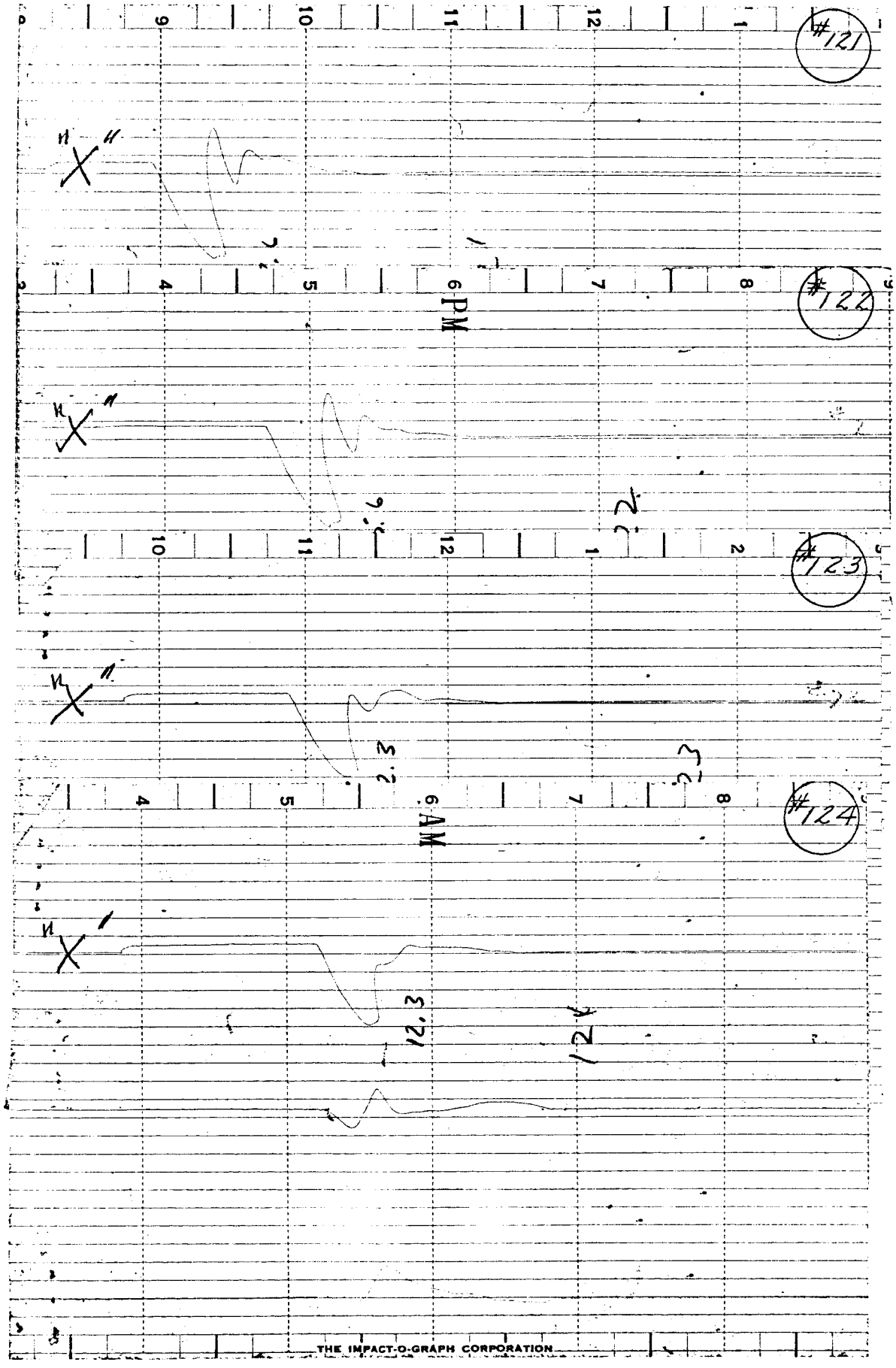
TEST #123

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact considerably in excess of 10 G's. Undesirable or unrepeatable rebound characteristics.

TEST #124


#121
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PM
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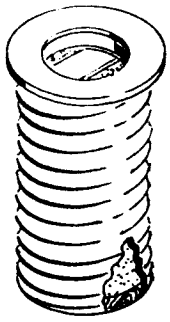
AM
THE IMPACT-O-GRAPH CORPORATION



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler compressed to 9" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Good shock dissipation characteristics except that impact was 12.3 G's. Marginal rebound characteristics.

TEST #125

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler compressed to 9" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics except that impact was 12.3 G's. Marginal rebound characteristics.

TEST #126

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler compressed to 9" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. 11.6 G's peak impact. Excellent rebound characteristics.

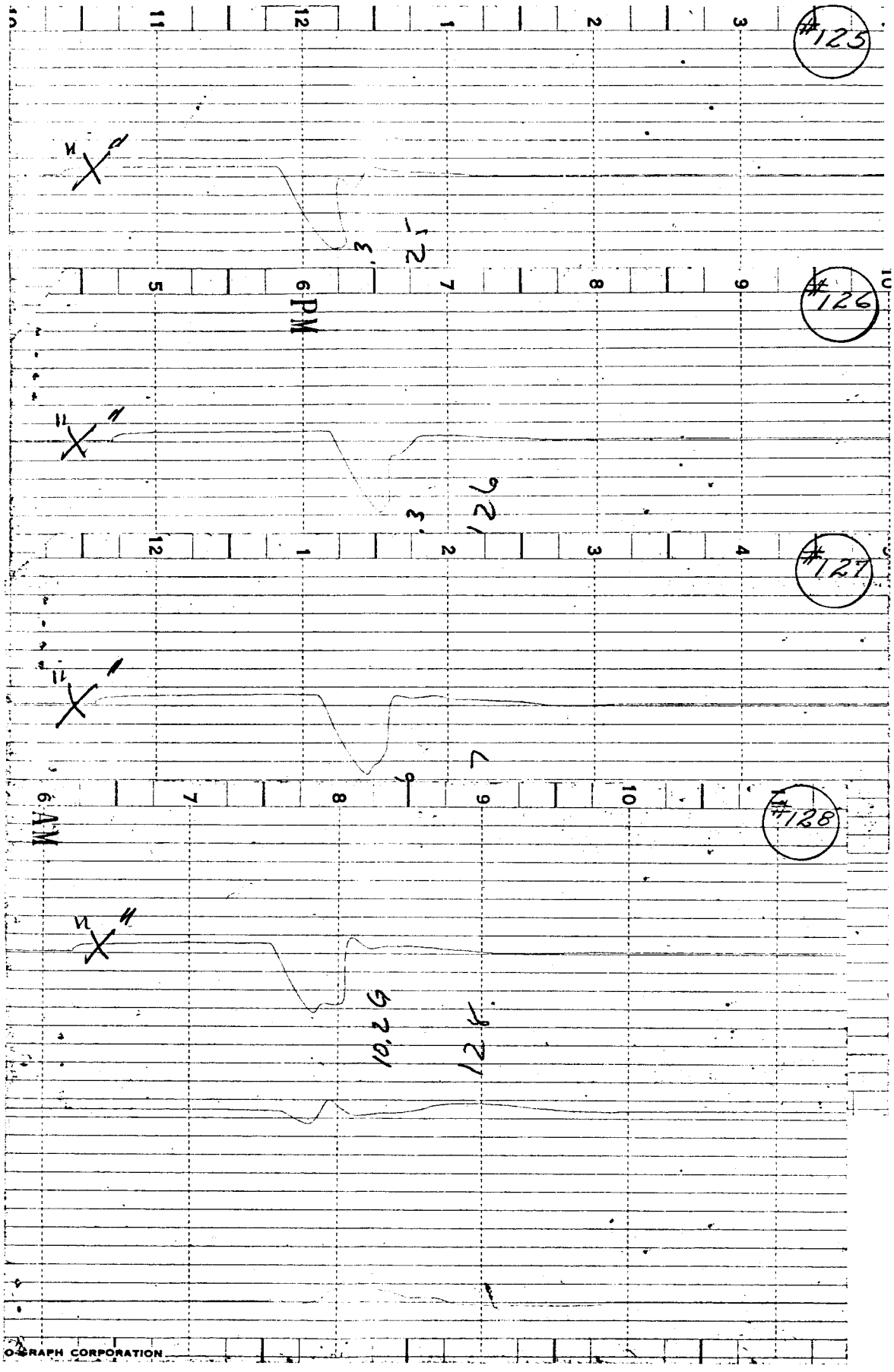
TEST #127

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler compressed to 9" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Impact peak 10.2 G's. Acceptable rebound characteristics.

TEST #128


#125
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#128
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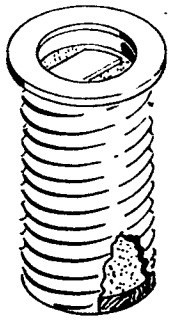
6 AM



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler compressed to 9" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Poor shock dissipation characteristics indicating column failure. Impact G's 10.9. Undesirable rebound characteristics.

TEST #129

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Impact peak 10.2 G's. Good rebound characteristics.

TEST #130

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact peak 10.9 G's. Unacceptable rebound characteristics.

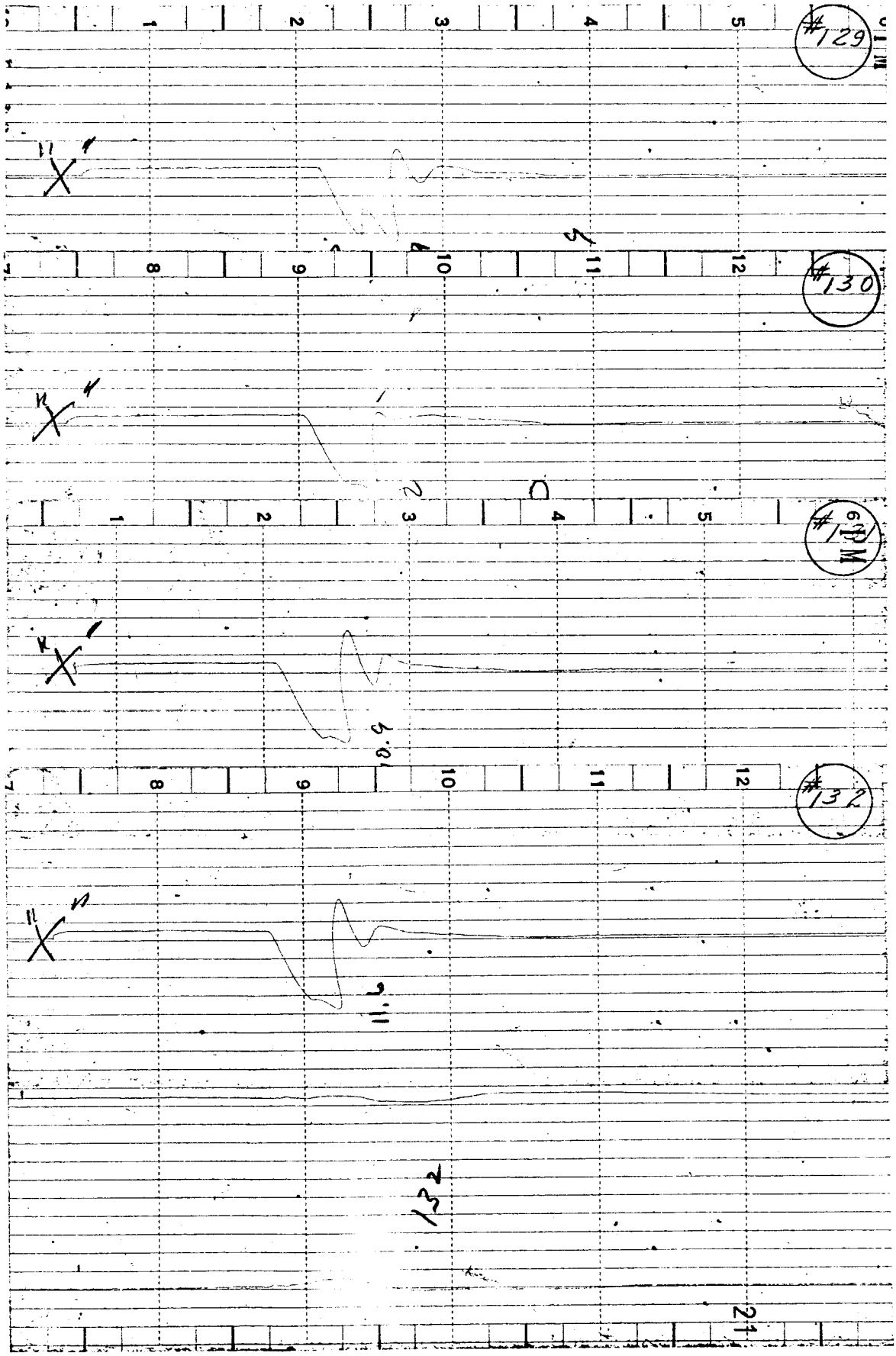
TEST #131

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact peak 11.6 G's. Unacceptable rebound characteristics.

TEST #132


#129
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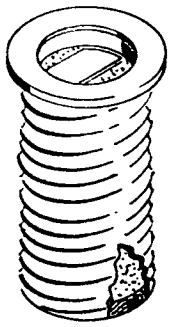
#132



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Marginal shock dissipation characteristics. Impact peak 11.6 G's. Unacceptable rebound characteristics.

TEST #133

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact peak 10.9 G's. Good rebound characteristics.

TEST #134

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact peak 11.6 G's. Unacceptable rebound characteristics.

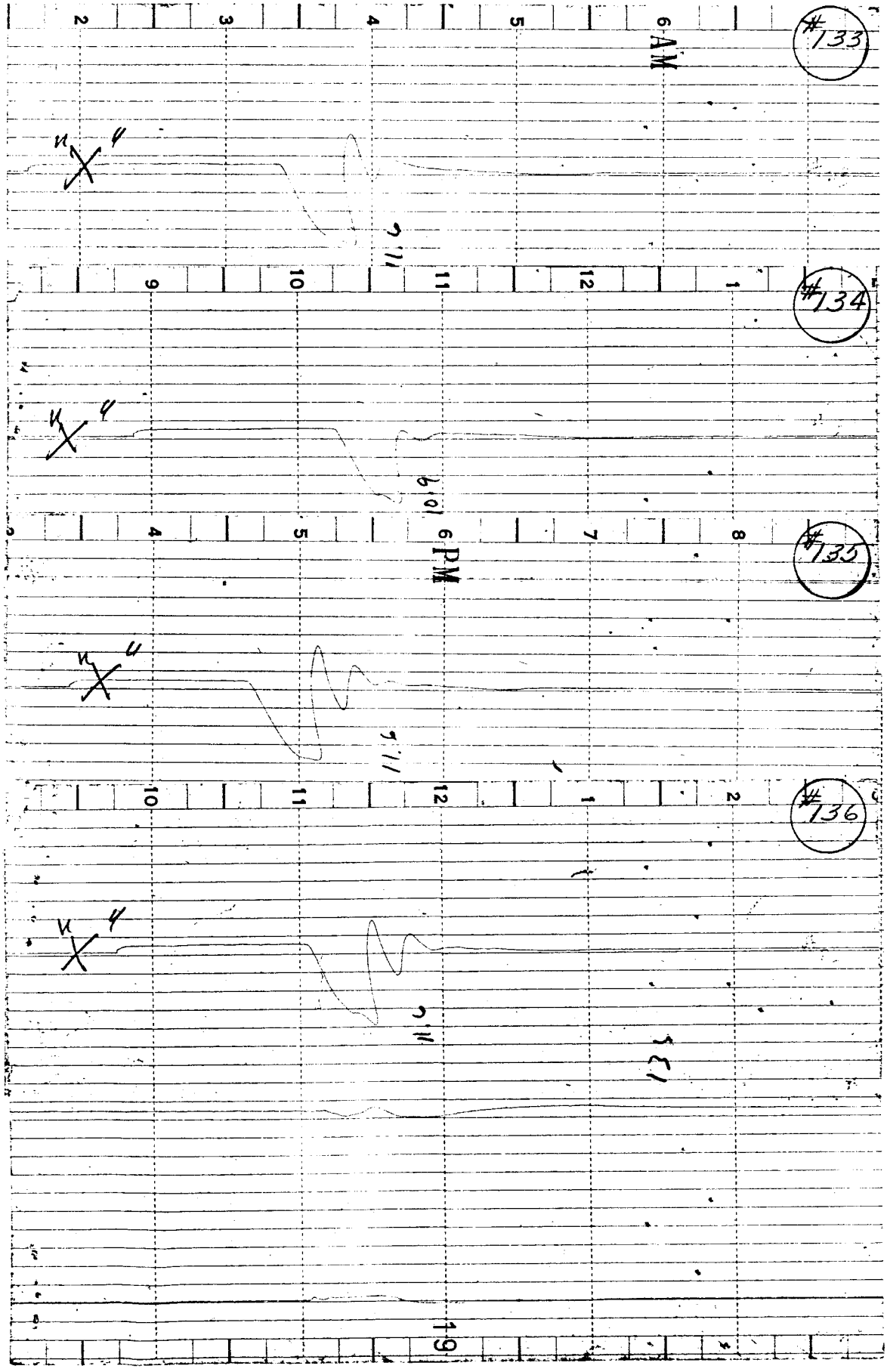
TEST #135

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly height 11-1/2". Polyurethane foam filler 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Marginal shock dissipation characteristics. Impact peak 11.6 G's. Unacceptable rebound characteristics.

TEST #136


#133
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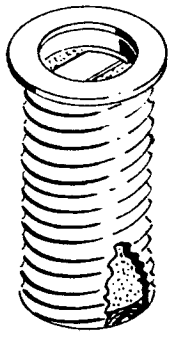
6'01
7'11
7'11
19



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 14" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Good shock dissipation characteristics, however, impact was 12.3 G's. Unacceptable rebound characteristics.

TEST #137

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 14" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. 10.9 G's peak. Indications of unstable rebound characteristics.

TEST #138

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 14" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. 10.9 G's peak. Indications of unstable rebound characteristics.

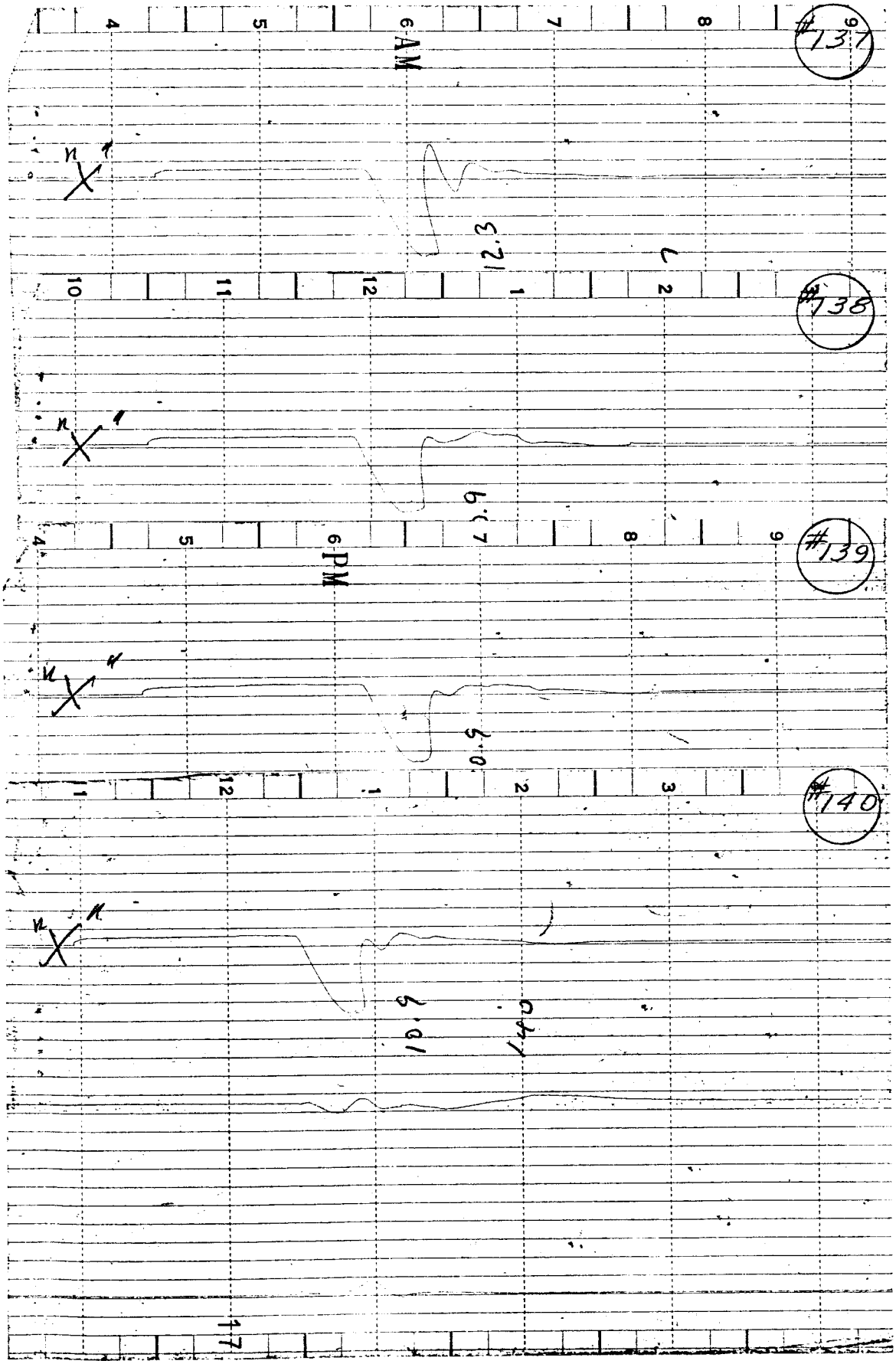
TEST #139

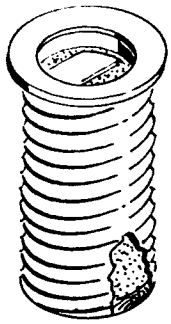
DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 14" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. 10.9 G's peak. Indications of unstable rebound characteristics.

TEST #140


#137
6 AM
N
3.21
#138
N
6.1
#139
6 PM
N
5.0
#140
N
5.91
11
17



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 14" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Good shock dissipation characteristics. 10.9 G's peak. Indications of unstable rebound characteristics.

TEST #141

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 17-1/2" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Impact considerably in excess of 10 G's. Marginal rebound characteristics.

TEST #142

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 17-1/2" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Impact considerably in excess of 10 G's. Marginal rebound characteristics.

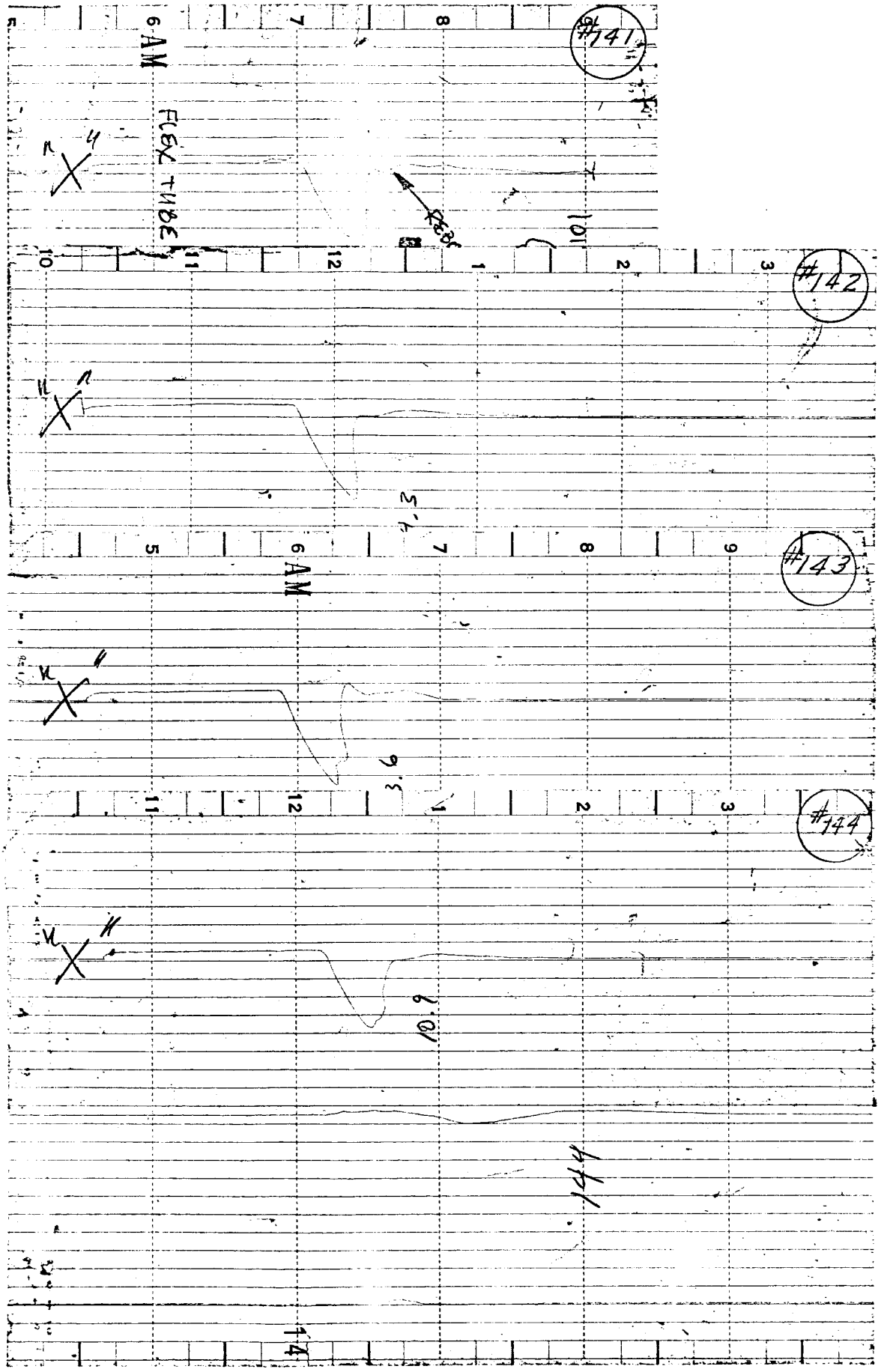
TEST #143

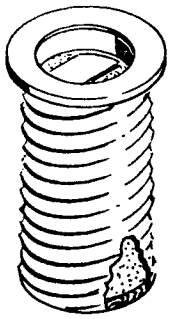
DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 15-3/4" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Slightly unstable recovery curve. Good rebound characteristics. 10.9 G's peak.

TEST #144


#141
6 AM
FLEX TUBE
#142
#143
6 AM
#144



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 15-3/4" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Good shock dissipation characteristics. Stable recovery. Acceptable rebound characteristics. 10.9 G's peak.

TEST #145

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 15-3/4" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Stable recovery. Acceptable rebound characteristics. 10.9 G's peak.

TEST #146

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 15-3/4" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Stable recovery. Acceptable rebound characteristics. 10.2 G's peak.

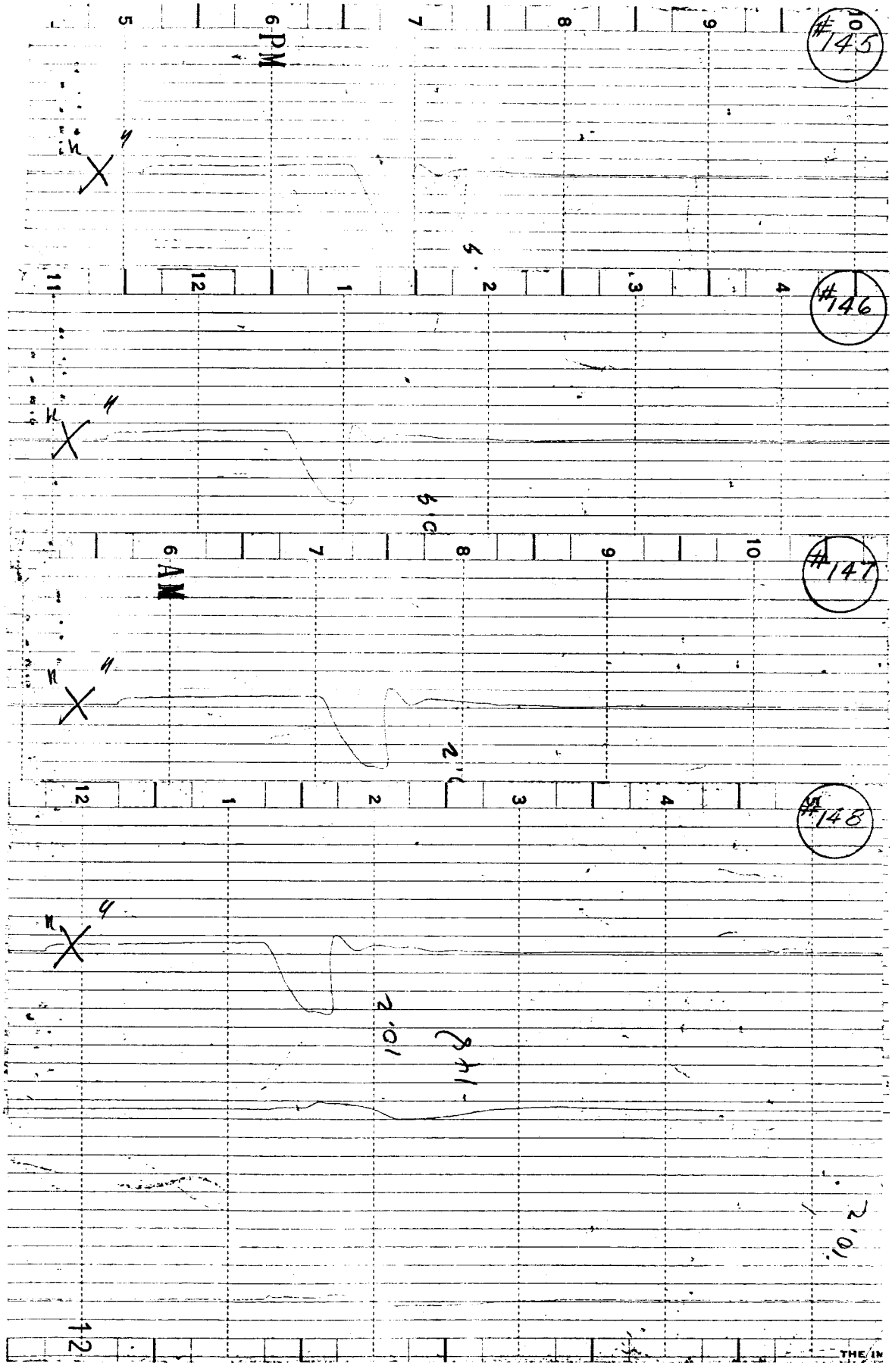
TEST #147

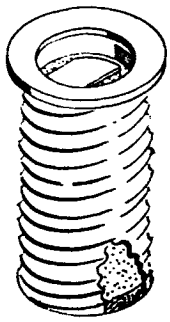
DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 15-3/4" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Stable recovery. Acceptable rebound characteristics. 10.2 G's peak.

TEST #148


#145
6 PM
#146
#147
6 AM
#148
THE IN



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 15-3/4" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

REMARKS: Good shock dissipation characteristics. Stable recovery. Acceptable rebound characteristics. 10.9 G's peak.

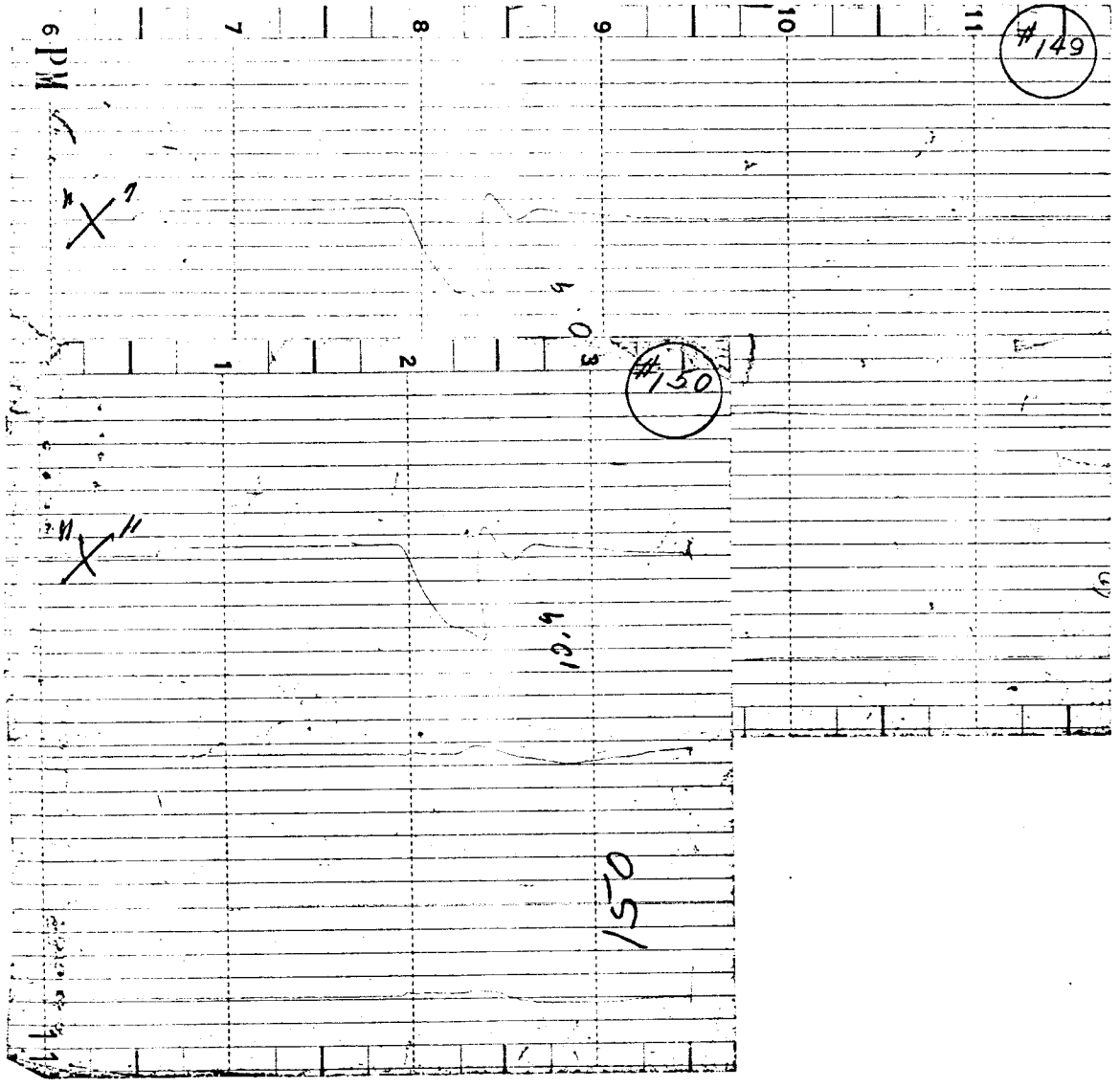
TEST #149

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, with 5/8" block on opposite end mounted to a flange assembly with 5-1/4" opening. Total duct assembly 11-1/2". 15-3/4" polyurethane foam filler compressed to 11-1/2" and retained by a 2" plate across the 5-1/4" opening.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Stable recovery. Acceptable rebound characteristics. 10.9 G's peak.

TEST #150


#149
#150
150

SELECTION - PARACHUTE CONFIGURATION.

In subject contract, Article I - Scope of Work, Paragraph B.1, specifies "that maximum shock to the capsule shall not exceed 10 g's for 50 milliseconds". Based on a "descending weight" of 20 pounds (capsule weight) as sensed by the parachute to be employed, it can be determined that the descent rate be limited to 16 feet per second.

Certain other characteristics for the parachute were desired, such as the following:

a. High drag coefficient.

b. Good damping characteristics.

c. Good stability (oscillating).

d. Low opening shock factor.

e. High opening reliability.

f. Low opening time.

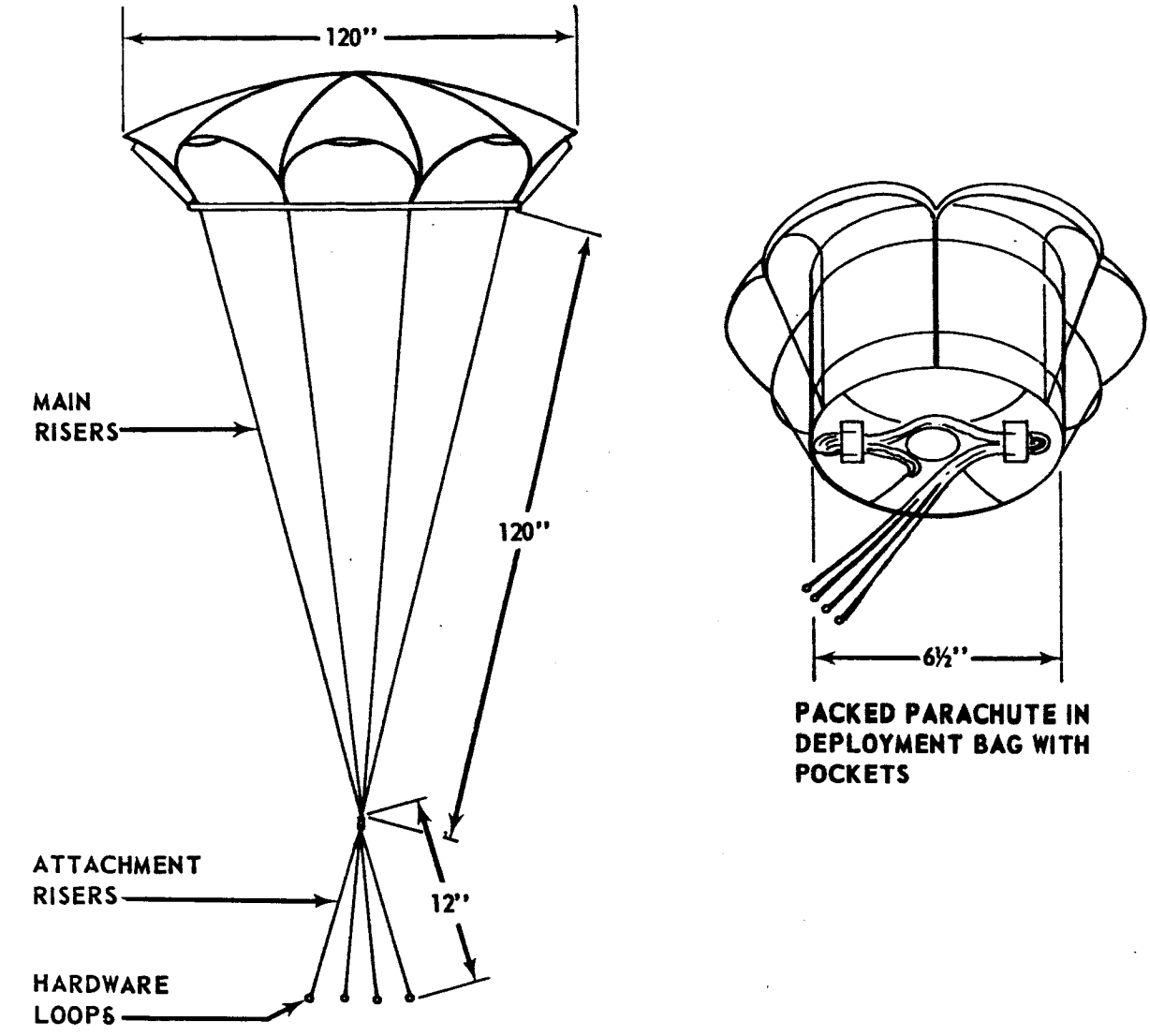
g. Easily packed.

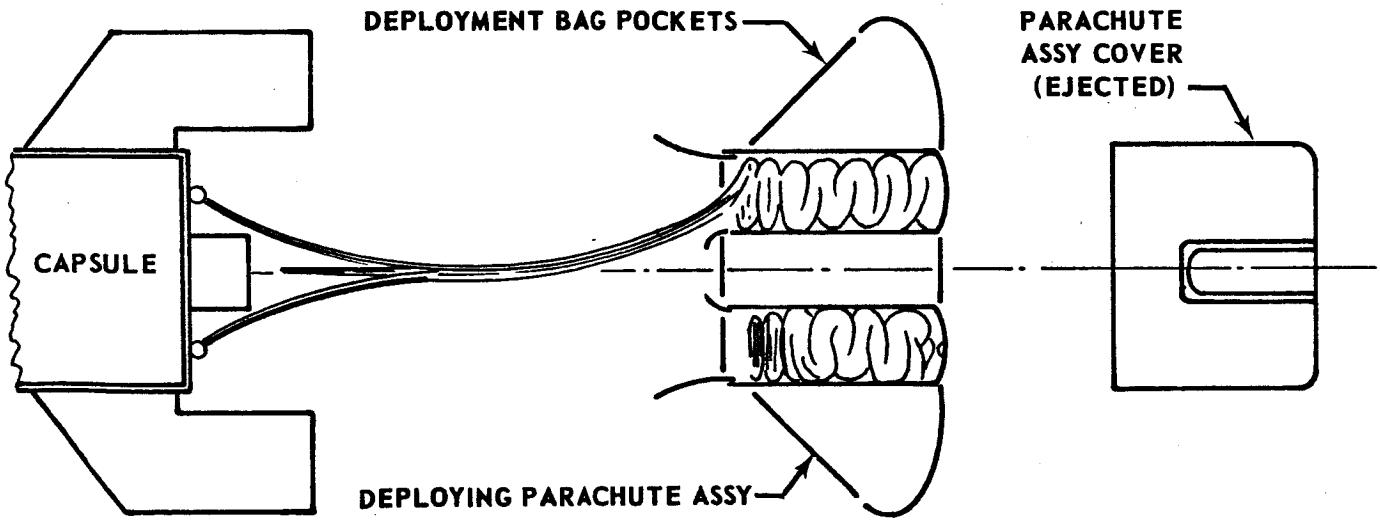
h. Reusable.

All of the above characteristics to the desirable degree were found to be available in the ribless guide surface type parachute. In the consideration of the above factors and the 16 fps required descent rate (which determines diameter), the parachute shown in Figures 8 and 9, and the specifications shown in Figure 10 depict the assembly used as the decelerator for both the Dummy and Modified Capsules.

FIGURE 9

PACKED PARACHUTE ASSEMBLY





PARACHUTE ASSEMBLY
FIGURE 8

PARACHUTE ASSEMBLY (SCD-10306) SPECIFICATIONS	
TYPE	Ribless Guide Surface
DIAMETER	120 Inches
GORES	Quantity 8
GORE MATERIAL	Nylon
GORE COLORS	Alternate Red/White
MAIN RISERS	120 Inches Long
ATTACHMENT RISERS	12 Inches Long w/ Hardware Loops
PACKING	Deployment Bag Type
WEIGHT - CANOPY AND RIDERS	2.4 pounds
WEIGHT - DEPLOYMENT BAG	0.25 pounds
VOLUME - CANOPY AND RISERS	160 Cubic Inches
VOLUME - DEPLOYMENT BAG	24 Cubic Inches
PACKING DENSITY	Nominal Hand Packed

FIGURE 10

PARACHUTE ASSEMBLY SPECIFICATIONS

DESIGN - DUMMY RECORDER CAPSULE.

The Dummy Recorder Capsule was designed and fabricated to possess certain mandatory characteristics of the actual Recorder Capsule such as physical configuration, dimensional envelope, weight, center of gravity, final nose cone configuration, control-arm circuit, and phrotechnic devices (thrusters, relays, batteries). Certain components such as the pyrotechnic devices were identical to those utilized on the Recorder Capsule. In the area of modification, the final nose cone configuration, parachute assembly, and deployment cover were identical to that to be utilized on the Modified Recorder Capsule.

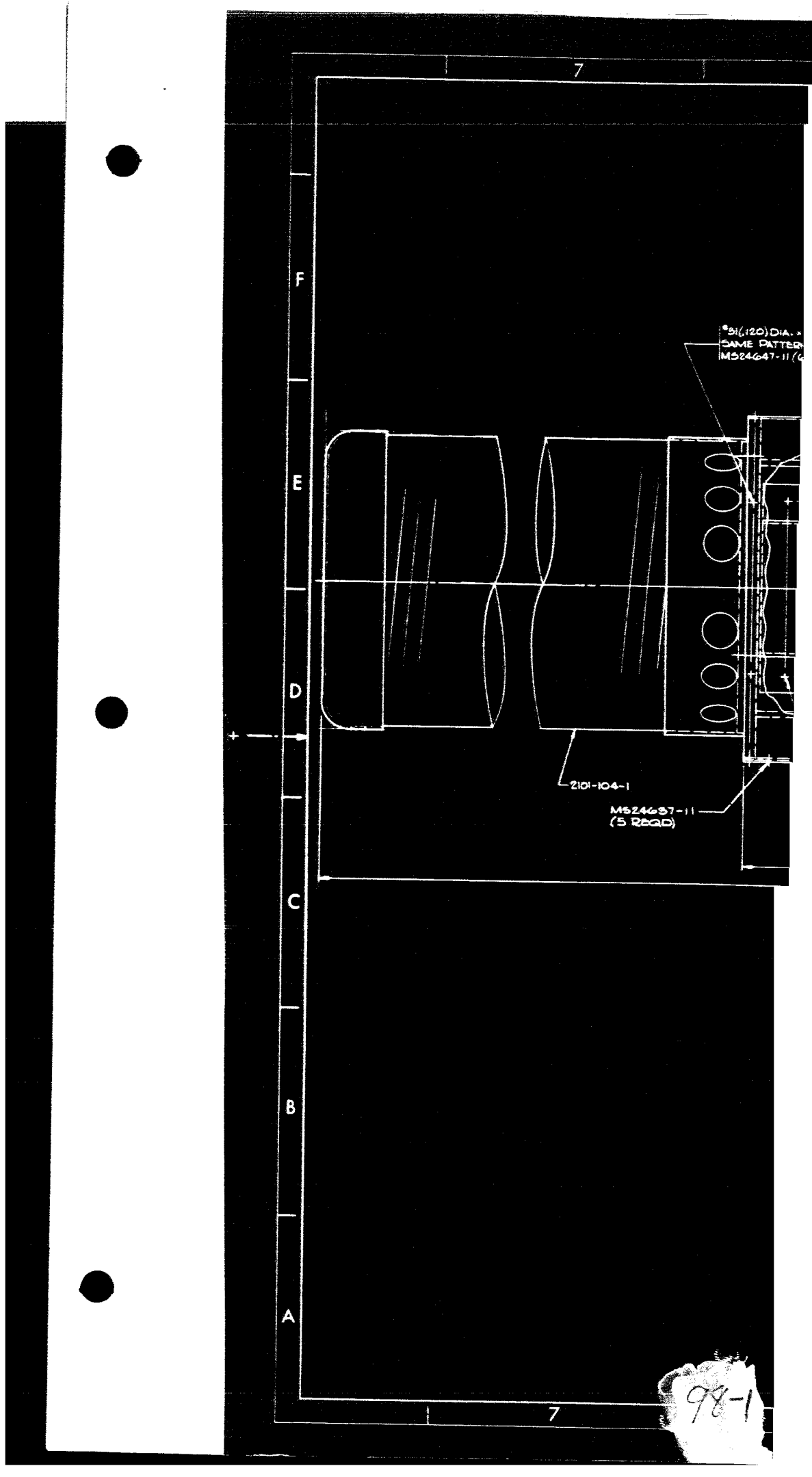
As can be seen, the Dummy Recorder Capsule contained an "on board" power supply for initiation of certain pyrotechnic devices to simulate "kick-off" from a vehicle and to provide power for the continuously recording Impact Recorder.

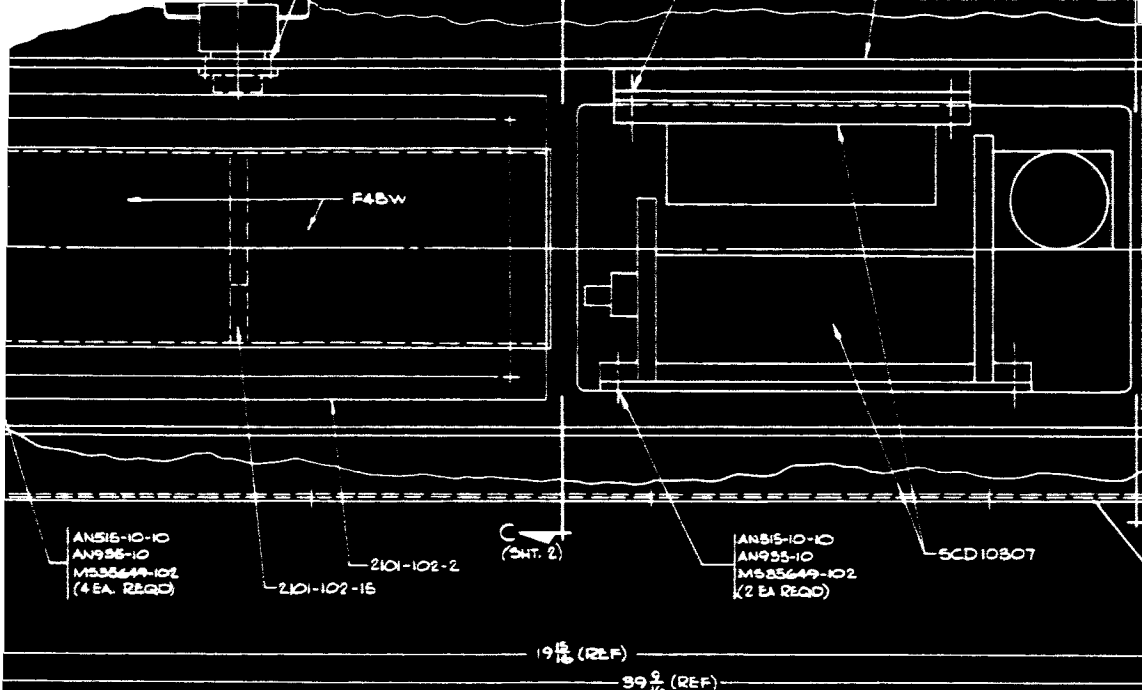
Figures 11-1, 11-2, 11-3, and 11-4 depict SPACE Corp. Drawing 2101-100 and the component list and shows the final tested configuration of the Dummy Recorder Capsule.

Figure 12 is a schematic of the safe/arm, and ejection circuit for the Dummy Capsule, identical with the actual Recorder Capsule except for system redundancy. All pyrotechnic devices are identical. Battery package shown was carried as "on board" power supply for the pyrotechnic devices and as a source of power for the Impact Recorder chart drive motor.

Figure 13 is a dimensional drawing of the 15 second pyrotechnic time delay relay as utilized.

Figure 14 is a photograph of the Dummy Recorder Capsule with the outside cover removed showing the internal component arrangement.


7
F
E
D
C
B
A
.91(.120) DIA. x
SAME PATTERN
MS24647-11 (4
2101-104-1
MS24657-11
(5 REQD)
7
98-1



① DUMMY RECORDER CAPSULE ASSY

NOTES CONT:

2 SEE SPACE DOCUMENT SK210-7 FOR PACKING INSTRUCTION FOR PARACHUTE

NOTES:

98-2

6 5 4

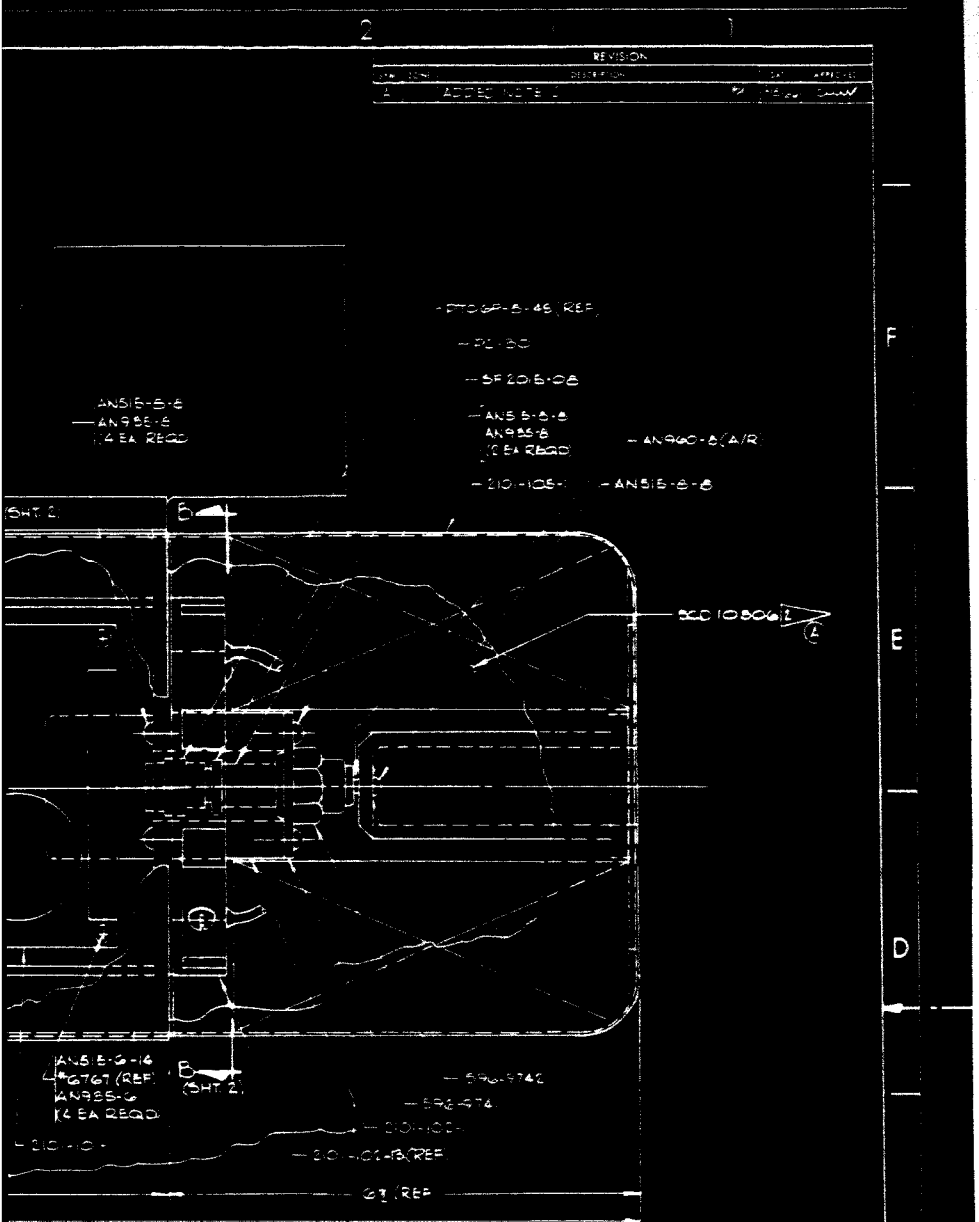


FIGURE 11-1

SEE BILL OF MATERIAL

PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	CODE IDENT.	MATERIAL OR NOTE	SPECIFICATION
PER DASH NO.	LIST OF MATERIALS OR PARTS LIST			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE

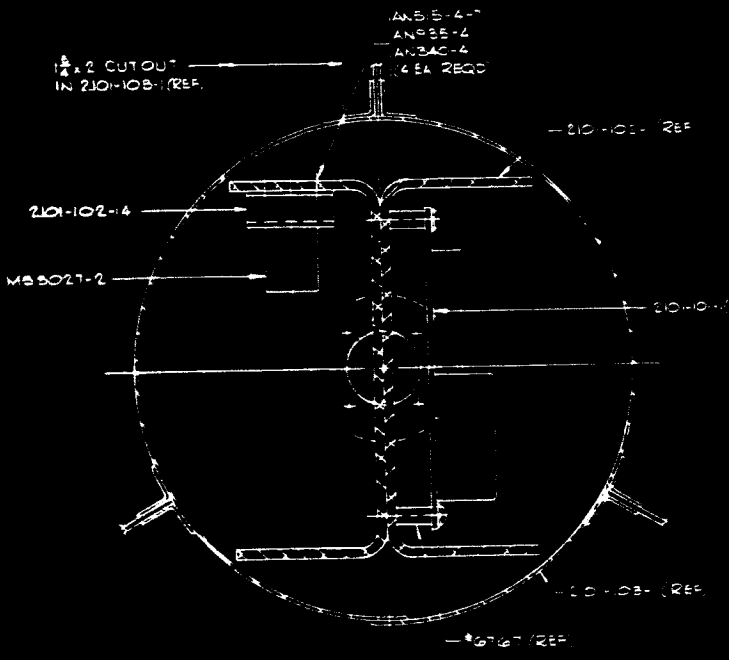
DRAWN BY
CKD BY
DESIGN ENG
MFGR ENG
ENGR MGR
APPROVED BY

SPACE CORP.
DALLAS TEXAS GARLAND

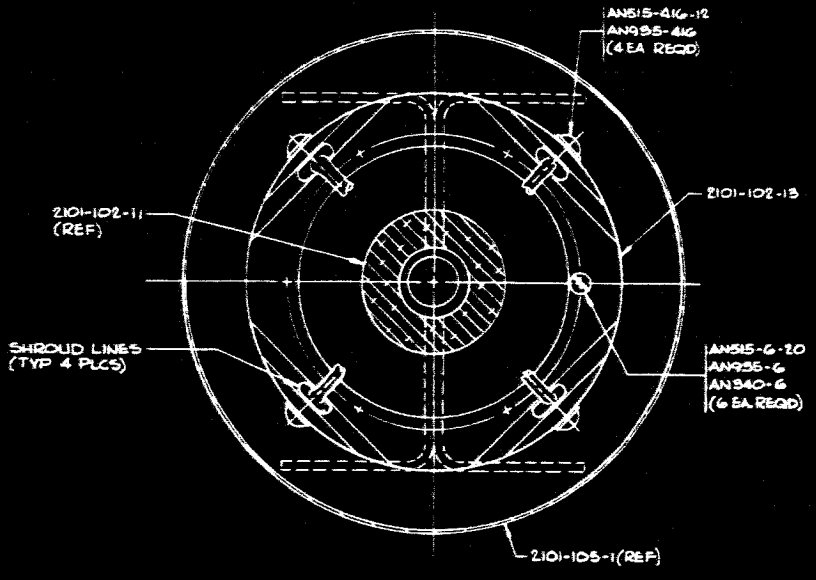
DUMMY RECORDER CAPSULE ASSEMBLY

04984 F

98-3


AN3-5-4
AN935-4
AN340-4
(6 EA REQD)
1 1/4 x 2 CUT OUT IN 2101-108-1 REF.
2101-102-1 REF
2101-102-4
MS5027-2
2101-108-1 REF
67.67 REF

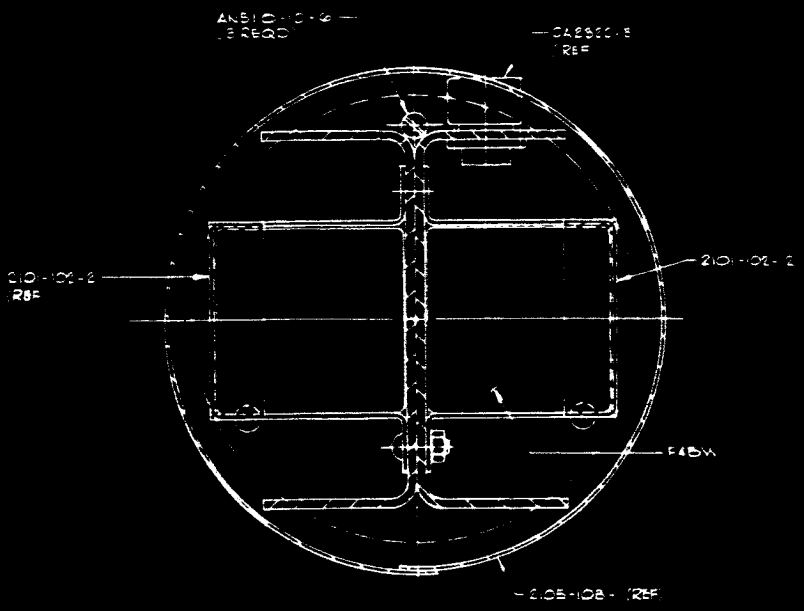
99-1



SECTION 'B-B'

SEE SHEET 1 FO

REVISION				
LTR	ZONE	DESCRIPTION	DATE	APPROVED



SECTION "C-C"

FIGURE 11-2

SEE P/L 2101-100 FOR MATERIAL

ITEM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL OR NOTE	SPECIFICATION
QTY REQD PER DASH NO	LIST OF MATERIALS OR PARTS LIST				

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE

DRAWN BY	BV
CKD BY	
DESIGN ENG	
MECH ENG	
ELECT ENG	
STRUCT ENG	
APPROVED BY	
DATE	

DESIGN ACTIVITY APPROVAL

SPACE CORP.
DALLAS TEXAS GARLAND

DUMMY RECORDER CAPSULE ASSEMBLY

CODE IDENT NO	SIZE	DRAWING NUMBER
04984	F	210-100

SCALE | SHEET 2

CONTRACT NO

923

CONTRACT NO.

SPACE CORP

DALLAS TEXAS GARLAN

QTY. REQD. PER DASH NO. | DWN. BY PCV | CKD BY [illegible] | APPVD

	-1	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
			-1	DUMMY RECORDER
	1		2101-101-1	CIRCUIT BOARD ASS
	1		2101-102-1	FRAME
	1		210-102-2	BATTERY BRACKET
	1		2101-102-11	EJECTION DEVICE HO
	1		2101-102-12	BATTERY BRACKET
	1		2101-102-13	PARACHUTE ANCHOR B
(A)	2		2101-102-15	SPACER
	1		2101-103-1	INSTRUMENT COVE
	1		2101-104-1	NOSE ASSY
	1		2101-105-1	PARACHUTE COVER
	1		2101-102-14	SWITCH BRACKET
*	1		SCD10207	IMPACT RECORDER
*	1		SCD10206	PARACHUTE ASSY
	1		596-9141	SUPPORT PLATE (C
	1		596-9142	NUT (CUT FOR
*	4		F4RW	BATTERY, DRY CEL
*	1		MS3102A12S-3S	RECEPTACLE
*	1		CA2[illegible]2-3	CAP
*	1		MS3027-2	SWITCH, DPST
*	1		SF2015-05	THRUSTER
*	1		PC-30	POWER CARTRIDGE

100-1

	CODE IDENT NO.	LM OR PL 2101-100	
D	04984	REV. (A) 2-7-66	SHT 1 OF 2 SHTS
BY CHIEF ENG.		TITLE DUMMY RECORDER CAPSULE ASSY	

OR	CODE IDENT.	MATERIAL OR NOTE	SPECIFICATION
APSULE ASSY			
Y			
SING			
ING			
R			
ASS'Y			
UCT. FURN.)			COOK ELECTRIC CO.
			COOK ELECTRIC CO.
, 2 VOLT	09823		
	71468		
	71468		
	15605		
			FIGURE 11-3
	73197		
	73197		

CONTRACT NO.

SPACE CORP

DALLAS TEXAS GARLAND

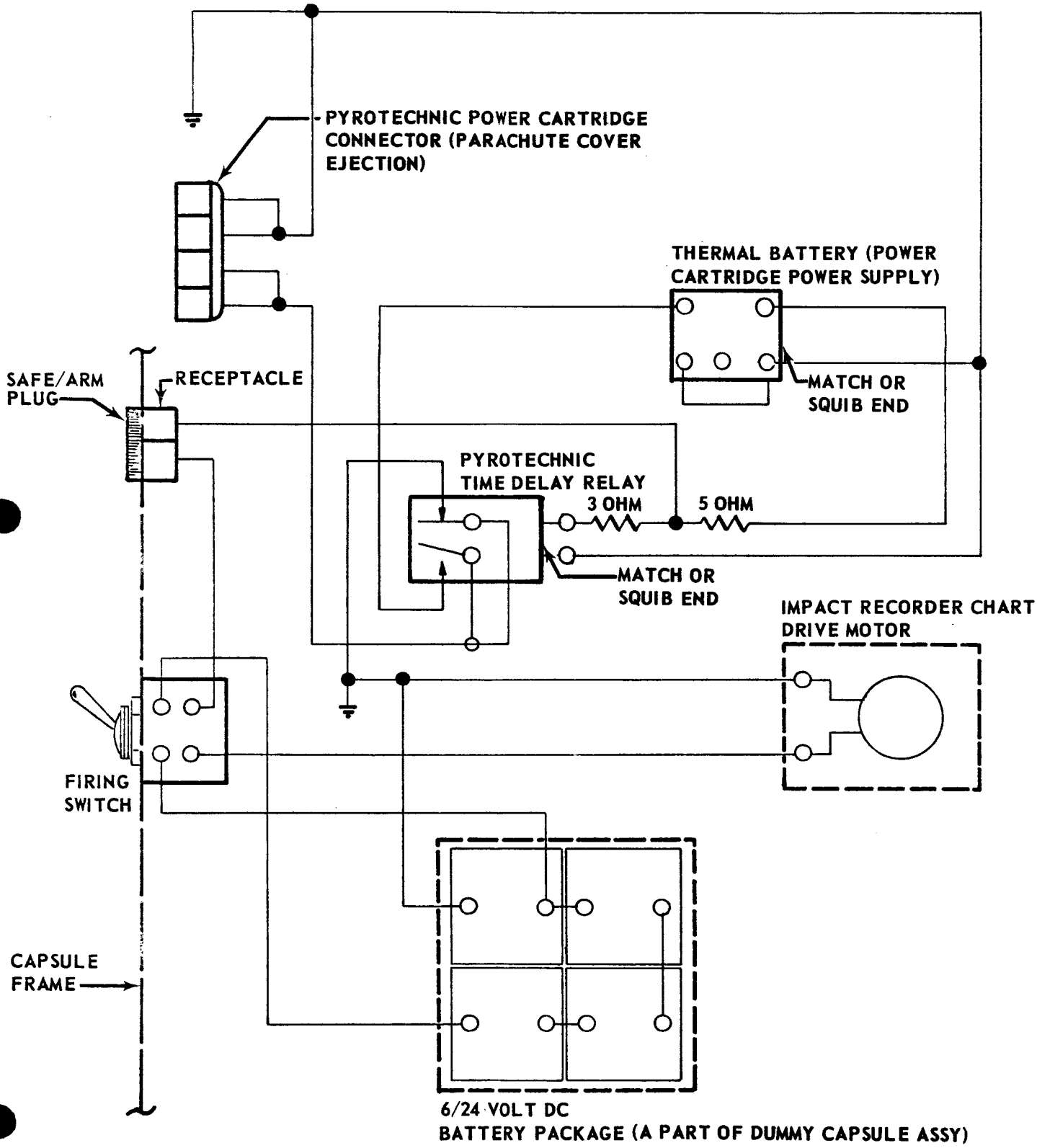
QTY. REQD. PER DASH NO. | DWN. BY BV | CKD BY | APPVD

-1	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
4		AN515-416-12	SCREW, 1/4-2[illegible]NC x
8		AN515-10-10	SCREW, #10-24NC x 5
3		AN510-10-6	SCREW, 82°CSK HD. x
7		AN515-8-3	SCREW, #8-32NC x
6		AN515-6-21	SCREW, #6-32NC x 1
4		AN515-6-14	SCREW, #6-32NC x
8		AN515-4-7	SCREW, #4-40NC x 7
5		MS24637-11	SCREW, SHT MTL, PAN H
6		MS24647-11	SCREW, SELF TAP, PAN HD
3		AN960-8	FLAT WASHER, #8
6		MS35649-102	NUT, #10-24NC
6		AN340-6	NUT, #6-32NC
8		AN340-4	NUT, #4-40NC
4		AN935-416	LOCK WASHER, 1/4
8		AN935-10	LOCK WASHER, #10
6		AN935-8	LOCK WASHER, #8
10		AN935-6	LOCK WASHER, #6
5		AN935-4	LOCK WASHER, #4
6		AN960-10	FLAT WASHER #10

CODE IDENT NO.	
04984	LM OR PL 2101-100
	REV. — SHT 2 OF 2 SHTS
BY [illegible] CHIEF ENG.	TITLE DUMMY RECORDER CAPSULE ASSY

...OR	CODE IDENT.	MATERIAL OR NOTE	SPECIFICATION
3/4 LG			
/8 LG.			
3/8 LG., #10-32 UNF			
/2 LG.			
/4 LG.			
/8 LG.			
/16 LG.			
, #6 x 3/8			
, TYPE "F", #6 x 3/8			

FIGURE 11-4

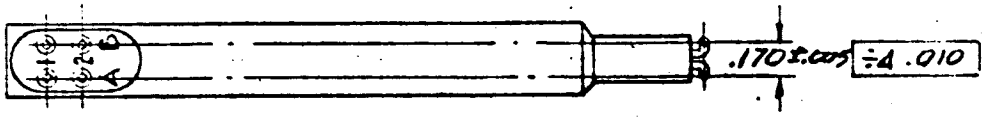


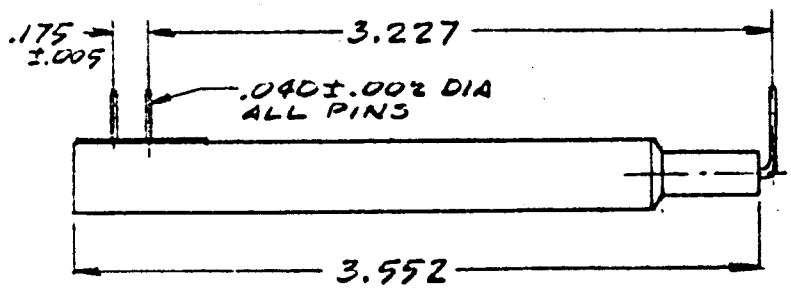
DUMMY CAPSULE SAFE/ARM EJECTION & IMPACT RECORDER CIRCUIT

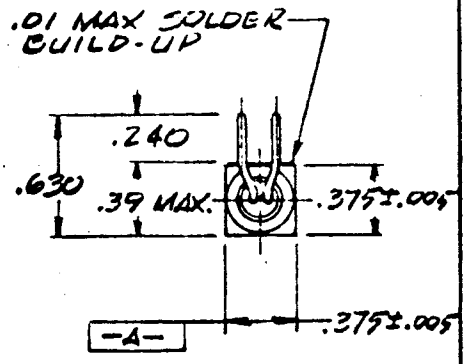
FIGURE 12

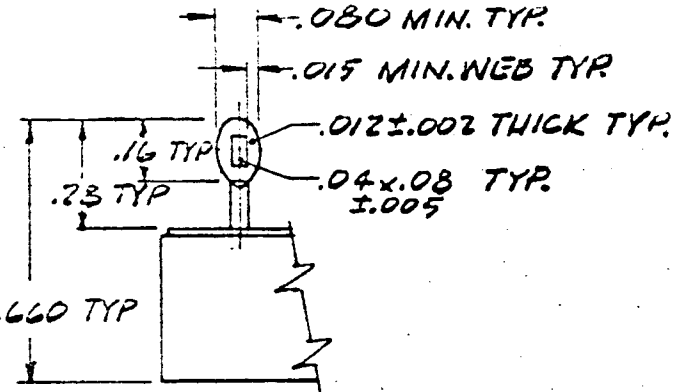
NO.	REVISIONS	DATE

ORIGINAL









OPTIONAL PINS
SCALE: 2-1
CODE REFERENCE: T1

MAT'L: ———		SCALE FULL	NOMINAL DIMENSIONS, 2 POLE, 12 TO 17 SEC. DELAY, 1 AMP-1 WATT RF PROTECTED MINIATURE SQUIB SWITCH
UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES FRACTIONS ± — ANGLES ± — DECIMALS ± .015 FINISH IS IN MICROINCHES		DRAWN BY STURGIS CHECKER PROJECT ENG. APPROVED BY APPROVED BY DATE 8-12-69	ATLAS CHEMICAL INDUSTRIES, INC. WILMINGTON 99, DEL. AEROSPACE COMPONENTS DIVISION
	NEXT ASS'Y.		SHEET OF NO. 1SW180

C. B. CO. 40-178 1-68

FIGURE 13

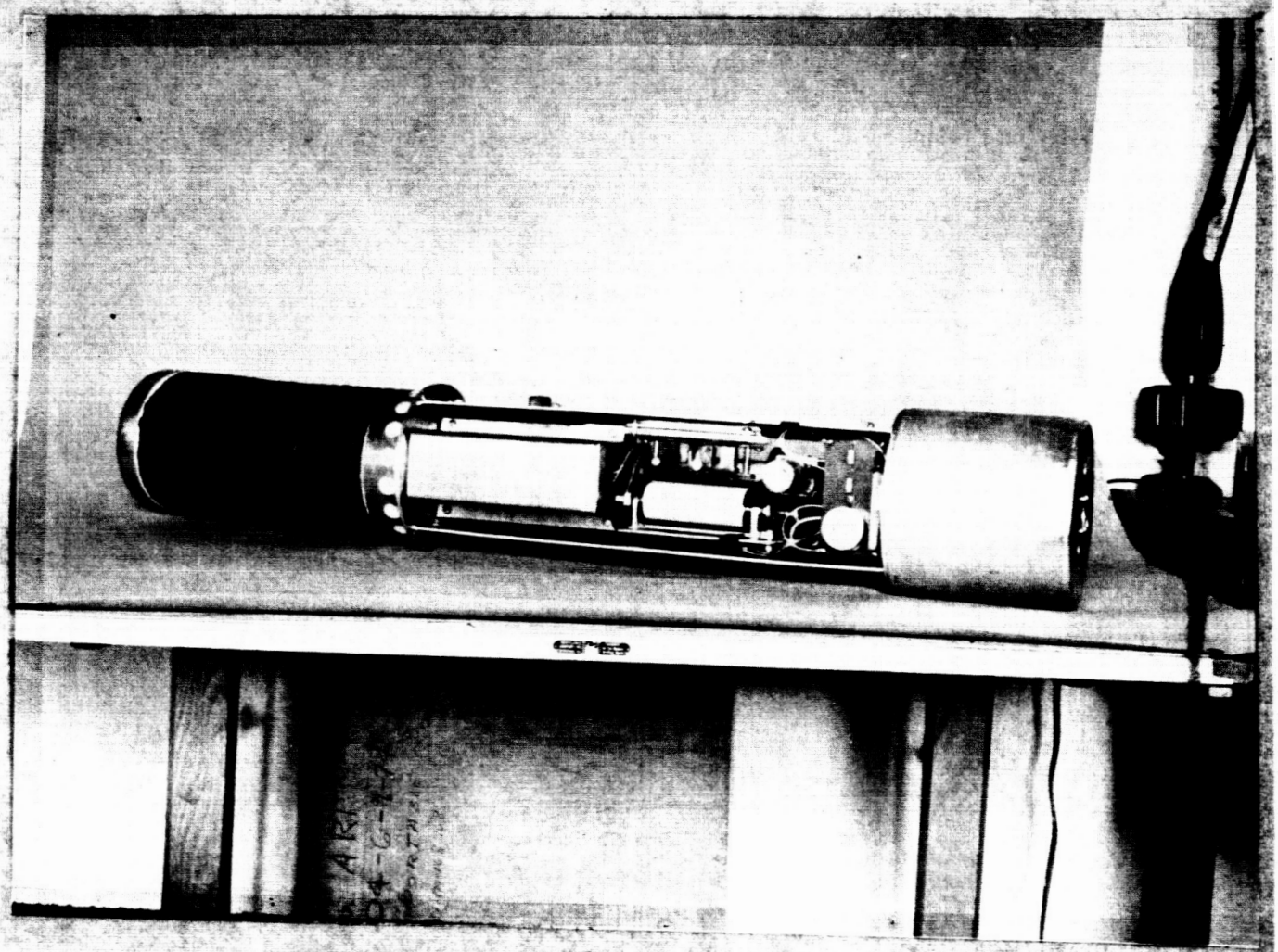


FIGURE 14

DUMMY RECORDER CAPSULE ASSEMBLY
COVER AND FIN ASSEMBLY REMOVED

DESIGN - MODIFIED RECORDER CAPSULE.

The GFE Recorder Capsule modification was designed to the extent that modifications were limited to a new nose cone configuration, modified forward cover to receive the nose cone, a fifteen second time delay relay circuit board assembly to replace the existing five second relays, and a parachute and deployment system to replace the existing streamer design.

All pyrotechnic devices remained unchanged except for the time delay relay, which was changed from a five second delay to a fifteen second delay. All other characteristics for this device remained unchanged.

Figures 16-1, 16-2, and 16-3 depict SPACE Corp. Drawing 2101-200 and the component list and show the final tested configuration of the Modified Recorder Capsule.

Figure 15 shows the printed circuit board assembly with the fifteen second time delay switches as utilized on the Modified Recorder Capsule.

Figure 17 is a photograph of the completed Modified Assembly, less tail fins.

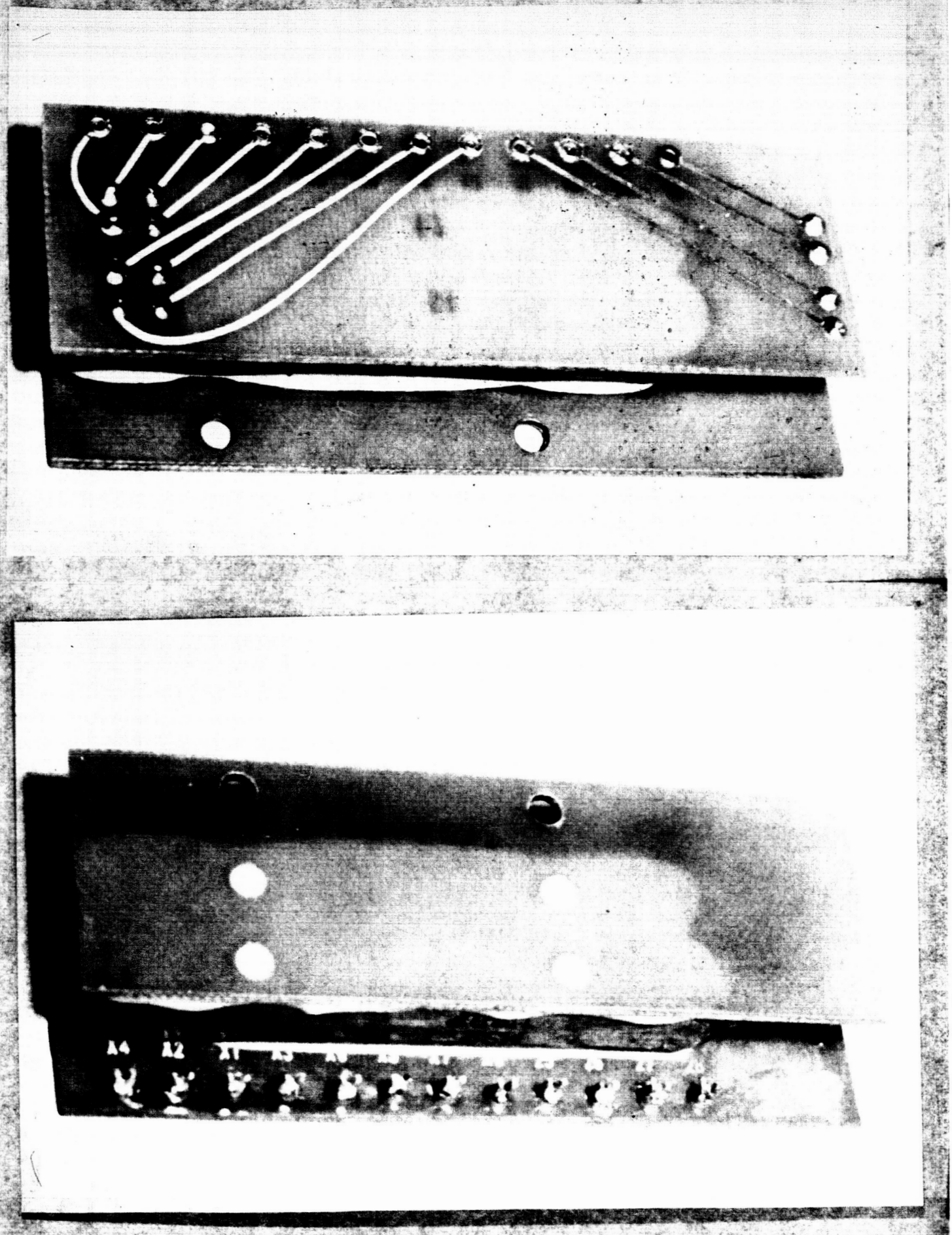
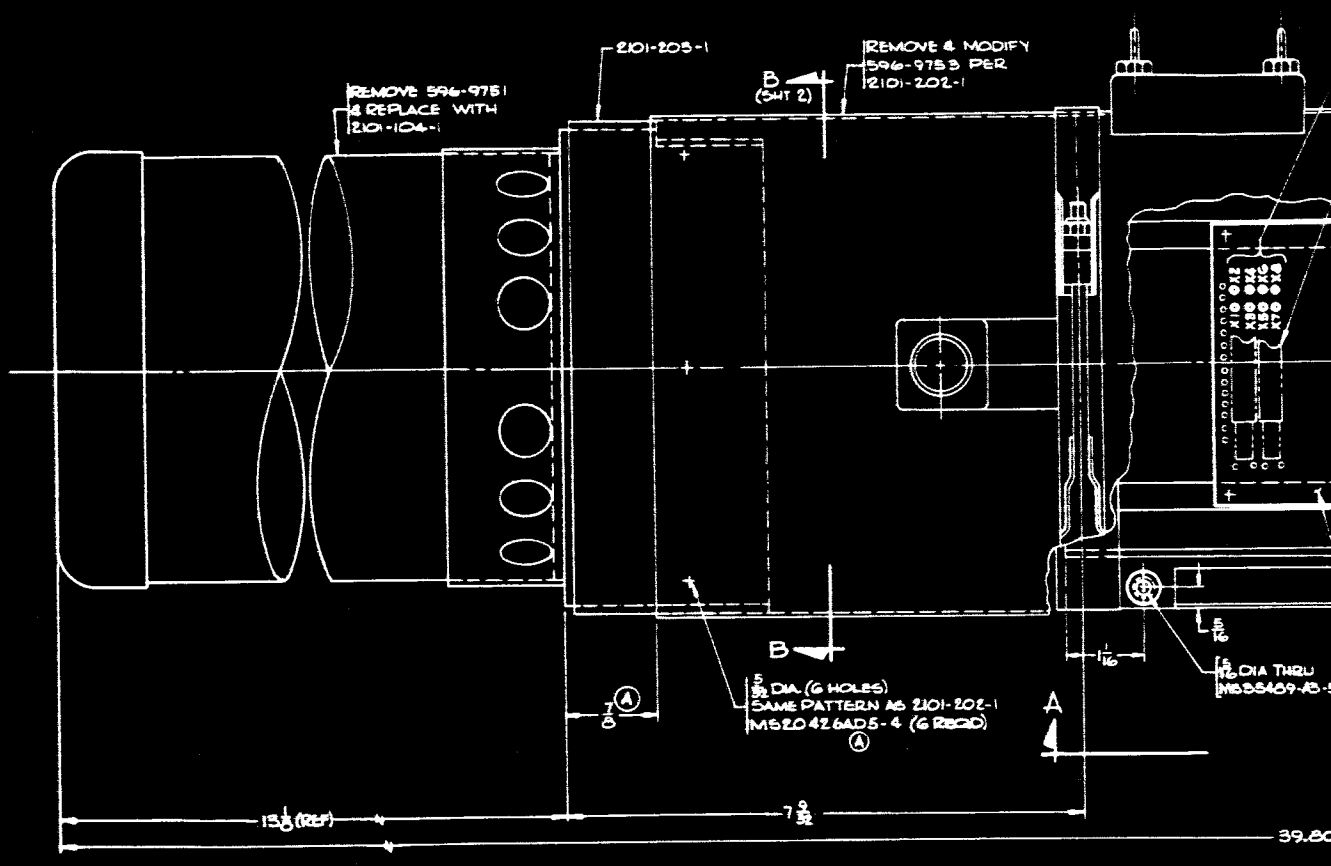


FIGURE 15

PRINTED CIRCUIT BOARD ASSEMBLY
UTILIZED IN THE MODIFIED RECORDER CAPSULE



NOTES CONT:

2 (A) REMOVE SURFACE FINISH FRON OF BOTH 596-9750 & 2101-20 THESE PARTS WITH EC-870 E.P ASSY AS P/N 2101-200-3.

5 (A) PAINT & PRIME P/N 2101-203-1 & CHROMATE & ENAMEL PER MIL- WHITE NO. 37875 OF STD 595.

4 (A) SEE SPACE DOCUMENT SK2101 PACKING INSTRUCTIONS.

REVISION					
SYM	ZONE	DESCRIPTION	DATE	APPROVED	
A		INC ECO'S 01, "AS BUILT"	BY	11/16/65	Cranfill

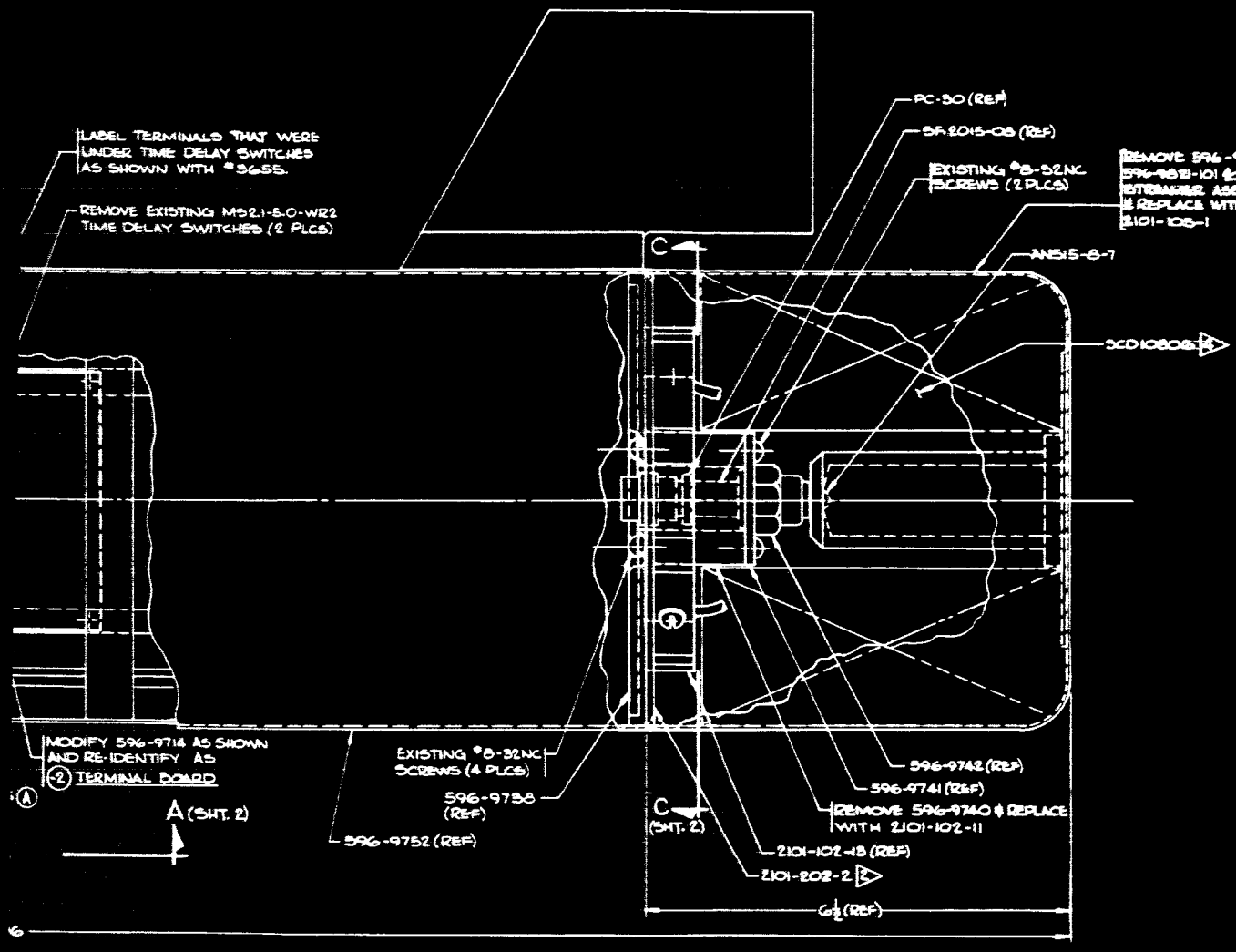


FIGURE 16-1

SEE P/L 2101-200 FOR MATERIAL

PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	CODE IDENT.	MATERIAL OR NOTE	SPECIFICATION
QTY. REQD. PER DASH NO.	LIST OF MATERIALS OR PARTS LIST			

NOTES:
1. IDENTIFY ALL PARTS PER MIL-STD-130
2. BREAK ALL SHARP EDGES & CORNERS .MAX
3. ALL MACHINED SURFACES TO HAVE MAX. 250 FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: DECIMALS ± ____ FRACTIONS ± 1/32 ANGLES ± ____

DRWN. BY	BV
CHK. BY	
DESIGN SUPV.	
MECH. SUPV.	
ELECT. SUPV.	
PROJECT ENGR.	
APPROVED BY	
DATE	11-15-65

DESIGN ACTIVITY APPROVAL

SPACE CORP.
DALLAS TEXAS

MODIFIED RECORDER CAPSULE ASSY (DR32-14)

CODE IDENT. NO.	SIZE	DRAWING NUMBER
04984	F	2101-200

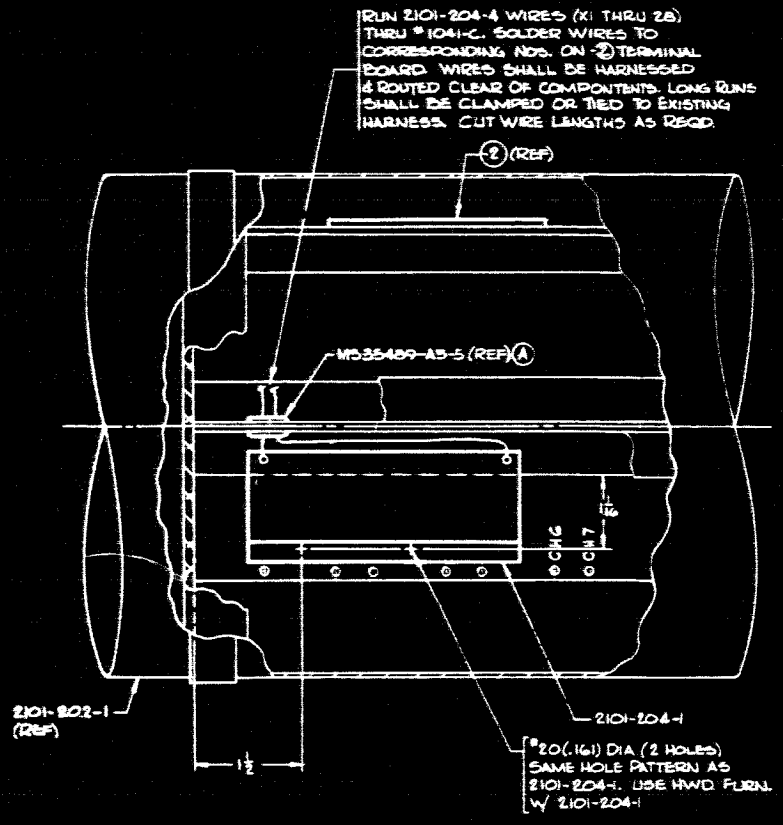
SCALE FULL | SHEET 1 OF 2

CONTRACT NO.

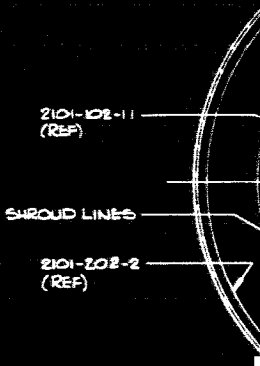
! CHAMFERED EDGE -2, THEN ATTACH DXY. IDENTIFY THIS

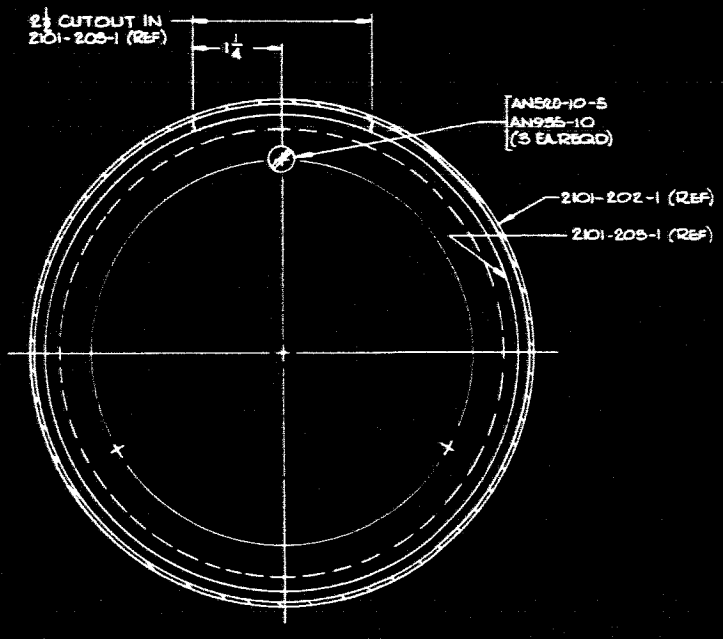
201-202-1 USE ZINC -10687B COLOR

FOR PARACHUTE



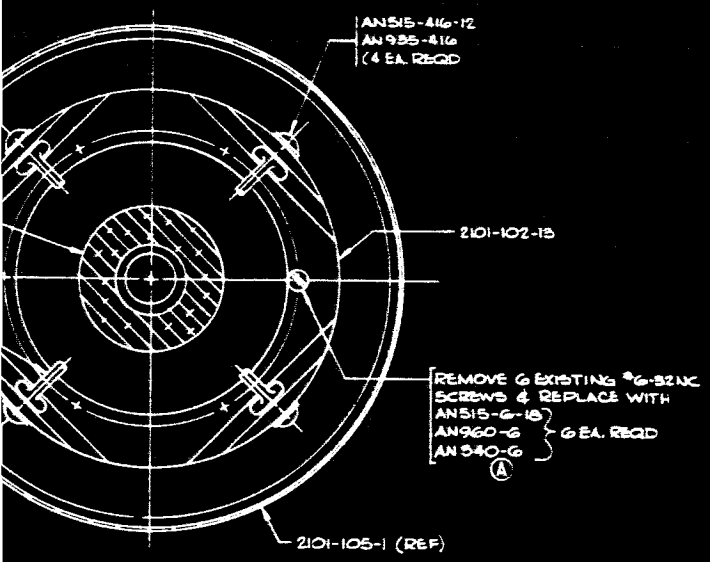
SECTION "A-A"





SECTION "B-B"

REVISION				
SYM	ZONE	DESCRIPTION	DATE	APPROVED
A		INC. ECO'S 01	10/17/66	[illegible]



SECTION "C-C"

FIGURE 16-2

See P/L 2101-200 FOR MATERIAL

PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	CODE IDENT.	MATERIAL OR NOTE	SPECIFICATION
QTY. REQD. PER DASH NO.	LIST OF MATERIALS OR PARTS LIST			

UNLESS OTHERWISE SPECIFIED
1. IDENTIFY ALL PARTS PER MIL-STD-130
2. BREAK ALL SHARP EDGES & CORNERS .010
3. ALL MACHINED SURFACES TO HAVE MAX. 250 FINISH.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE [illegible]

SEE SHEET 1 FOR GENERAL NOTES

DRWN. BY BV
CHD. BY
DESIGN ENG.
MECH. ENG.
ELECT. ENG.
APPROVED BY
DATE 10-16-64

DESIGN ACTIVITY APPROVAL

SPACE CORP.
DALLAS TEXAS GARLAND

MODIFIED RECORDER CAPSULE ASSY (DR32-14)

CODE IDENT NO.	SIZE	DRAWING NUMBER
04984	F	2101-200

SCALE 12"=1.0" SHEET 2

CONTRACT NO.

CONTRACT NO. _____

SPACE CORP

DALLAS TEXAS GARLAN

QTY. REQD. PER DASH NO. | DWN. BY FEV | CKD BY _____ | APPVD

	-2	-1	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
		X		-1	MODIFIED RECORDER
		1		-2	TERMINAL BOARD
		1		DR32-14	RECORDER CAPSULE
		1		2101-102-11	EJECTION DEVICE
		1		2101-102-13	PARACHUTE ANCHOR
		1		2101-104-1	NOSE ASSY
		1		2101-105-1	PARACHUTE COVE
		1		2101-202-1	COVER MODIFICATION
		1		2101-202-2	PARACHUTE COVER
		1		2101-203-1	NOSE CONE ADAP
		1		2101-204-1	CIRCUIT BOARD AS
*		1		SCD10306	PARACHUTE ASSY
	1			596-9714	TERMINAL BOARD (
(A)		6		AN340-6	NUT #6-32 NC
*		A/R		#EC 870	EPOXY
(A) *		1		MS35489-A35	GROMMET
	A/R			#3655	SCOTCHCAL FILM, BL
(A) * !		6		MS20426AD5-4	RIVET, FLAT HD, 5/32 D
		4		AN515-416-12	SCREW, 1/4-20NC x
		3		AN520-10-5	SCREW, #10-32NF x
		6		AN515-6-18	SCREW, #6-32NC x
		1		AN515-8-7	SCREW, #8-32NC
		4		AN935-416	LOCK WASHER, 1/4
		3		AN935-10	LOCK WASHER, #10
(A) ! *		6		AN960-6	FLAT WASHER, #6

	CODE IDENT NO.	LM OR PL 2101-200	
D	04984	REV (A) 2-7-66	SHT 1 OF 1 SHTS
BY Thiel CHIEF ENG.		TITLE MODIFIED RECORDER CAPSULE ASSY (DR32-14)	

OR	CODE IDENT.	MATERIAL OR NOTE	SPECIFICATION
2 CAPSULE ASSY			
. ASSY (CUST FURN)			COOK ELECTRIC CO.
HOUSING			
. RING			
R			
ADAPTER			
TER			
SY			
TBD, A PART OF DR32-14			
			3M
ACK-PS			3M
AX 1/4 Lg, 100°	CSK		
3/4 Lg.			
5/16 Lg.			
1 1/8 Lg.			
7/16 Lg.			

FIGURE 16-3

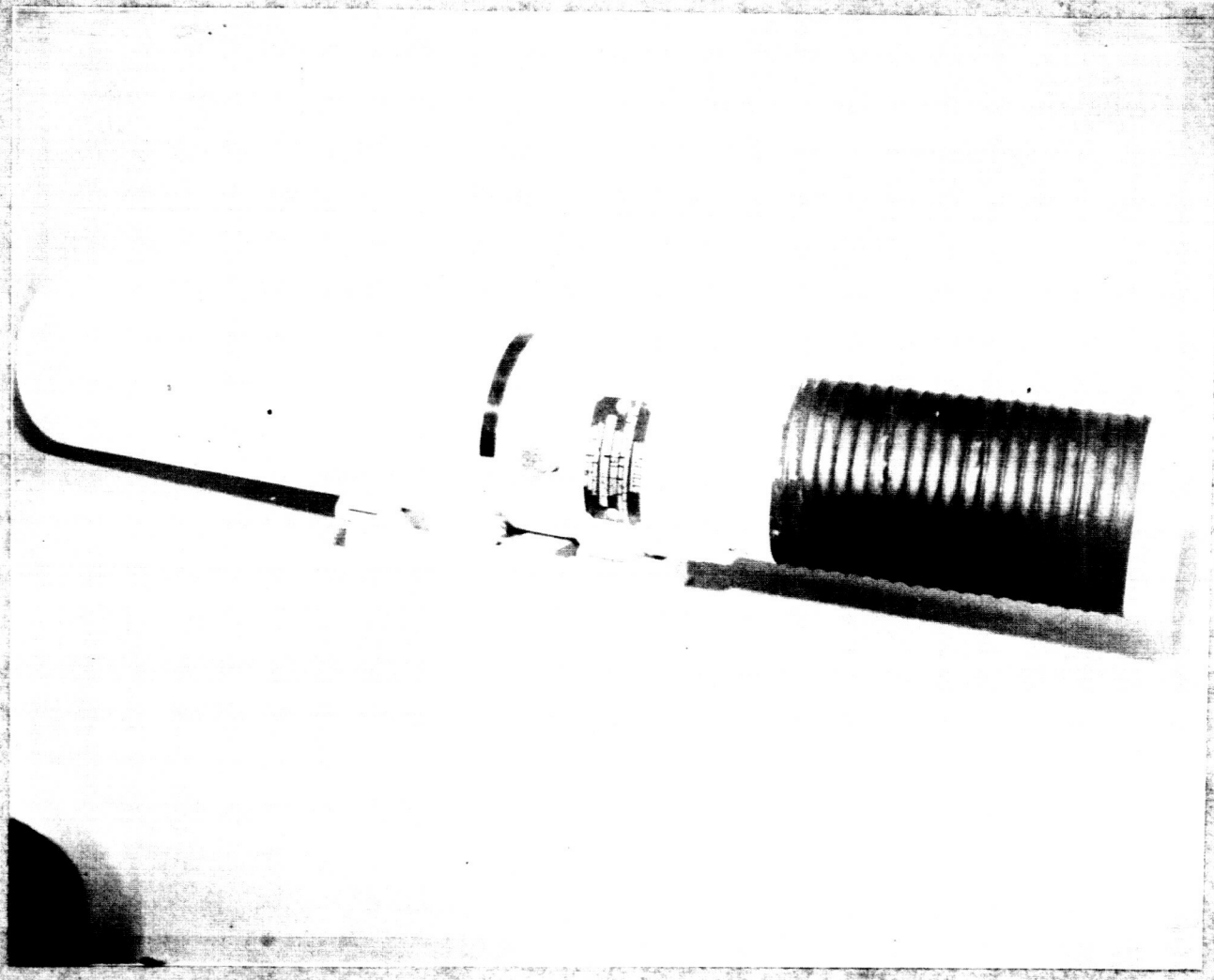


FIGURE 17

MODIFIED RECORDER CAPSULE ASSEMBLY
LESS TAIL FINS

DROP TESTS - GENERAL.

All drop tests for both the Dummy Recorder and Modified Recorder Capsule were staged and performed at an unused emergency air field at Caddo Mills, Texas. See Figure 18. This site was the closest suitable location to SPACE Corp. wherein the dropping or jettisoning of objects from an aircraft is permitted by the FAA upon prior notice by SPACE Corp.

Figure 18 is a reproduction of an U. S. Air Force Navigation Chart showing the Caddo Mills air strip location with respect to Garland, Texas.

The aircraft utilized for all the test drops was a Hiller H23B Helicopter. To this aircraft was adapted a drop tube to receive either the Dummy Recorder Capsule or the Modified Recorder Capsule. Access openings were incorporated in the drop tube for arming either of the capsules and a pin release arrangement at the upper end operating through a fin of either capsule provided a safe instantaneous release system.

Figure 19 is a photograph of the Hiller H23B Helicopter at the Caddo Mills air strip. Mounted to the helicopter is the drop tube previously described. The two Recorder Capsules are also shown; Dummy Capsule to the left and Modified Capsule to the right.

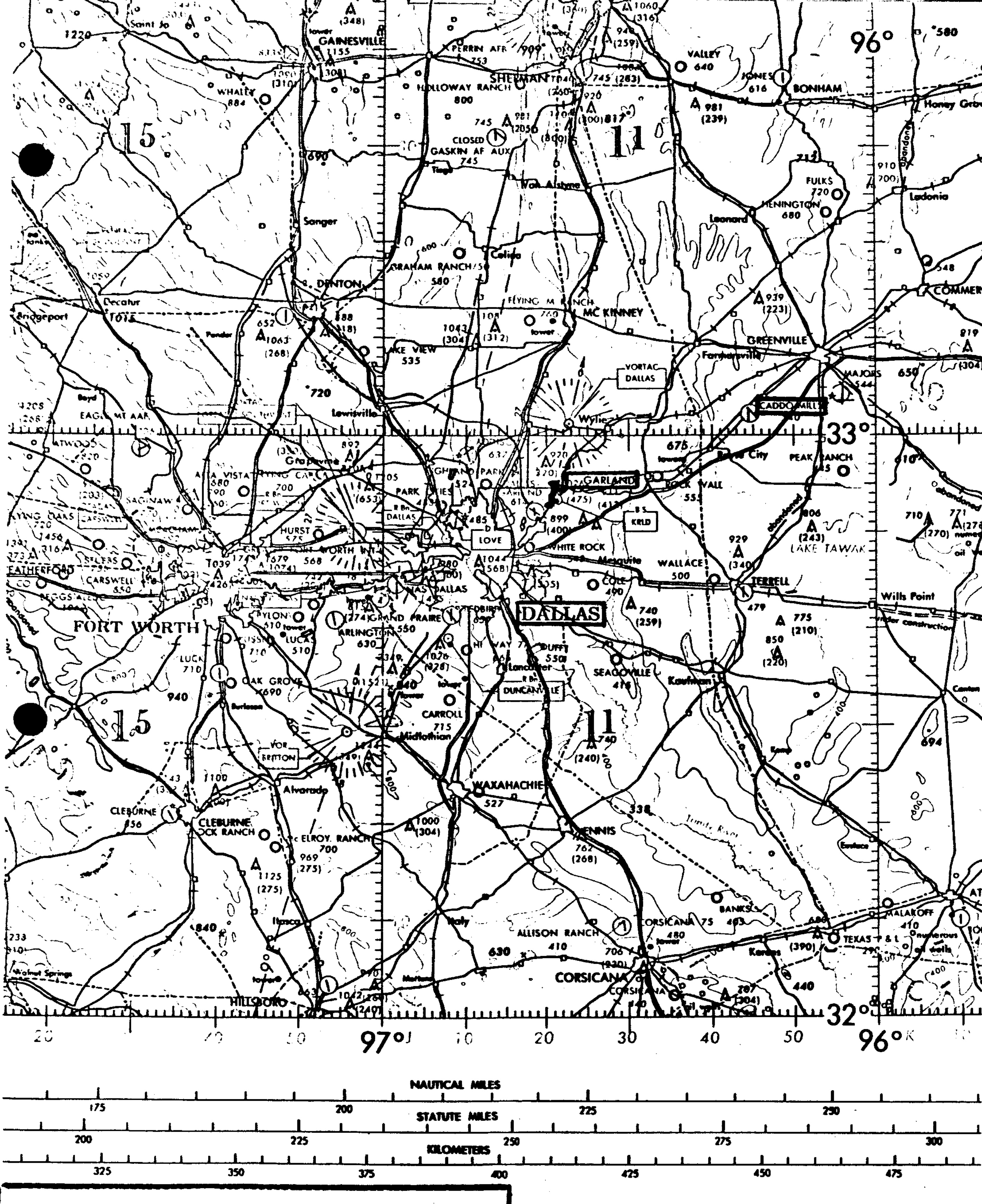


FIGURE 18

CADDO MILLS, TEXAS TEST DROP GEOGRAPHICAL LOCATION

Lambert Conformal Conic Projection
Standard Parallels 32°40′ and 35°20′
Convergence Factor .55924

CONVERSION OF ELEVATIONS

FEET (thousands) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

METERS (thousands) 0 1 2 3 4 5 6 7 8 9

NOTE: It is requested that all users of this chart mark hereon corrections and additions which come to their attention and mail direct to COMMANDER, AERONAUTICAL CHART AND INFORMATION CENTER, SECOND AND ARSENAL, ST. LOUIS, MISSOURI 63118, ATTN. ACDB.

FIGURE 19

DROP TEST VEHICLE -
HILLER H23B HELICOPTER

DROP ALTITUDE.

In accordance with Modification No. 1 to the subject contract, it was required that "The test drops shall be initiated at such a calculated altitude as necessary to simulate a capsule ejection from a booster at an altitude of 2,000 feet".

It was originally assumed that if:

a. Booster acceleration is 17.5 feet/sec.^{2} vertically

b. Capsule ejection altitude would be 2,000 feet

c. The aerodynamic drag of the Recorder Capsule at ejection is neglected

d. The ejection velocity from the booster horizontally is 30 - 35 feet/sec.

Then the booster velocity at 2,000 feet would be 264 feet/sec. and the Recorder Capsule maximum attained trajectory altitude will be 3,081 feet. Activation of the 15 second time delay relay deploys the parachute at an approximate altitude of 2,300 feet. Allowing additional altitude (time) for completion of deployment, the Recorder Capsule is descending from an altitude of approximately 1800 feet.

On the basis of the above, it was necessary to determine what altitude for drop or release of the Recorder Capsule would approximate the ejection and acceleration trajectory for parachute deployment at approximately 2,300 feet. It was calculated (based on an assumed drag coefficient) that this drop altitude would be 5,435 feet.

Subsequent sections show that the original calculated altitude was based on a low value drag coefficient compared to the actual. Re-evaluation of these factors resulted in revision of the drop altitude to 4,200 feet. See Drop Tests - Dummy Recorder Capsule and Drop Tests - Modified Recorder Capsule.

DROP TESTS - DUMMY RECORDER CAPSULE.

Prior to formal drop tests the Dummy Recorder Capsule was test dropped at SPACE Corp. from a test height of 48 inches to verify the capability of the test configuration overall system. Strip Chart Tests #1A through #6A (Pages 116 - 119) depict the impact results. At no test did the impact exceed 10 g's; average as shown is 9.5 g's.

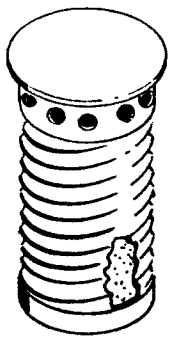
Following this verification, the Dummy Recorder Capsule was outfitted with a fresh battery power supply, and made "safe" by removal of the "arm" cap.

The Dummy Recorder Test was staged at the Caddo Mills air strip on November 30, 1965.

The test drop for the Dummy Recorder Capsule was performed in accordance with SPACE Corp. Document 2101-T1 Test Drop Procedure and Results for Dummy Recorder Capsule P/N 2101-100; however, the test was unsuccessful. The Dummy Recorder Capsule impacted the ground at terminal velocity due to failure of the parachute system to deploy.

Post test evaluation of the unsuccessful test drop revealed that the time delay relay had been incorrectly wired due to misinterpreted circuit characteristics information on the body of the relay. In spite of this malfunction it was established that the thermal battery ignited and that the time delay relay "match" also ignited; however, at the conclusion of its "burn", the incorrect wiring at the switch end of the relay body did not cause the firing circuit to the parachute cover thruster to ignite the power cartridge for ejection of the cover.

Consequently the Capsule struck the ground at terminal velocity determined to be an average of 68.2 miles per hour (100 feet/sec.) calculated from altitude and drop time data obtained during this test. See Appendix D - Data Sheet No. 1 and No. 2 from Test Procedure Document 2101-T1. This is stated as average due to the various observed attitudes of the Capsule during descent, causing a varying drag coefficient.



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, and with a dished aluminum head of approximately 020 material. Opposite end closed, flange mounted with peripheral hole openings. Overall assembly height 13-1/8". Assembly filled with 16" of polyurethane foam filler compressed to 13". Peripheral opening 3/4" diameter, 16 places.

REMARKS: Good shock dissipation characteristics. Good repeatablility for peak G's. 9.3 G's maximum impact.

TEST #1A

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, and with a dished aluminum head of approximately 020 material. Opposite end closed, flange mounted with peripheral hole openings. Overall assembly height 13-1/8". Assembly filled with 16" of polyurethane foam filler compressed to 13". Peripheral opening 3/4" diameter, 16 places.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Good repeatability for peak G's. 9.3 G's maximum impact.

TEST #2A

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, and with a dished aluminum head of approximately 020 material. Opposite end closed, flange mounted with peripheral hole openings. Overall assembly height 13-1/8". Assembly filled with 16" of polyurethane foam filler compressed to 13". Peripheral opening 3/4" diameter, 16 places.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Good repeatability for peak G's. 9.5 G's maximum impact.

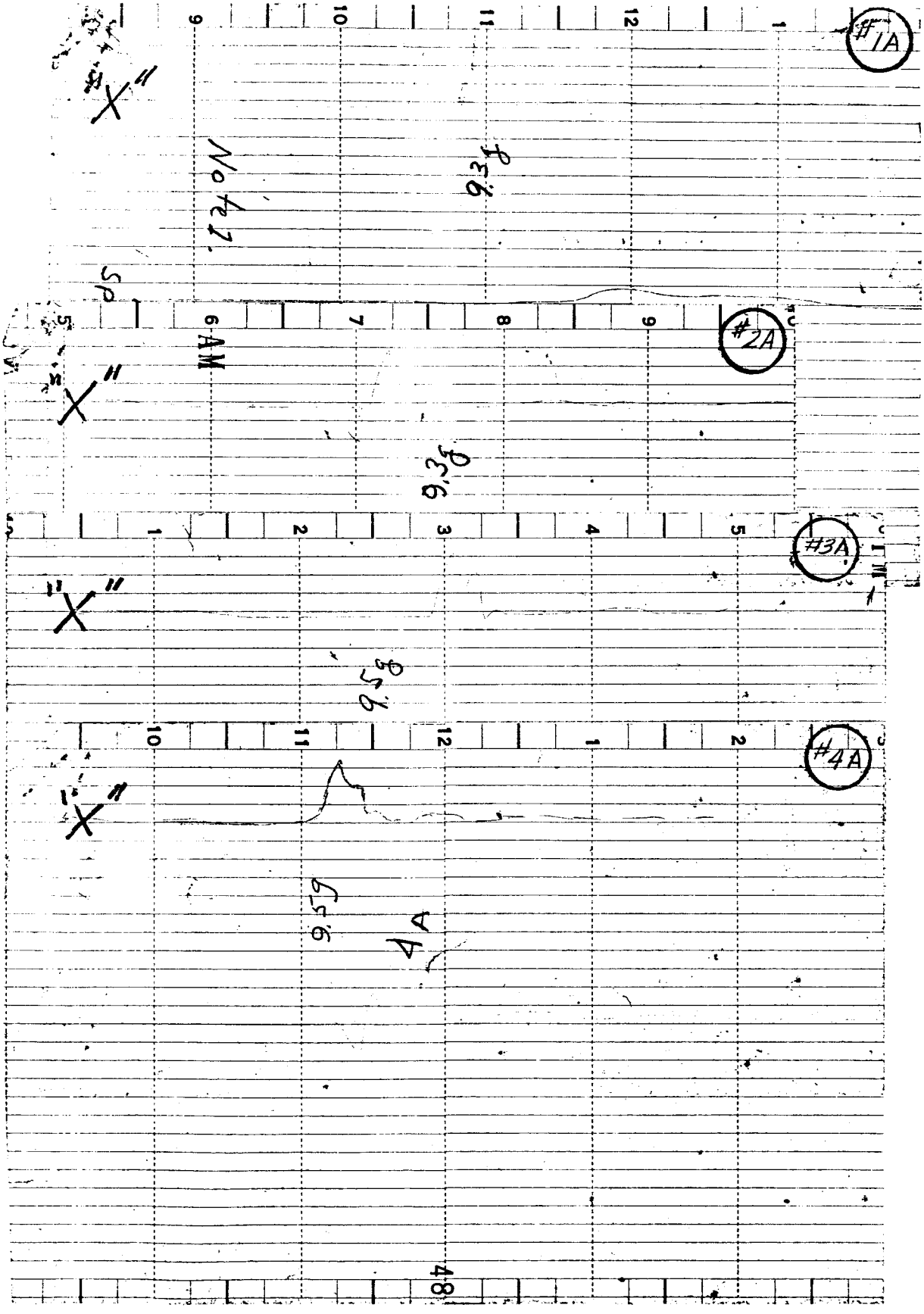
TEST #3A

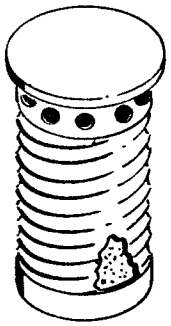
DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, and with a dished aluminum head of approximately 020 material. Opposite end closed, flange mounted with peripheral hole openings. Overall assembly height 13-1/8". Assembly filled with 16" of polyurethane foam filler compressed to 13". Peripheral opening 3/4" diameter, 16 places.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Good repeatability for peak G's. 9.5 G's maximum impact.

TEST #4A


#1A
#2A
#3A
#4A
9,38
9,35
9,59
4A
48



DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, and with a dished aluminum head of approximately 020 material. Opposite end closed, flange mounted with peripheral hole openings. Overall assembly height 13-1/8". Assembly filled with 16" of polyurethane foam filler compressed to 13". Peripheral opening 3/4" diameter, 16 places.

REMARKS: Good shock dissipation characteristics. Good repeatability for peak G's. 9.5 G's maximum impact.

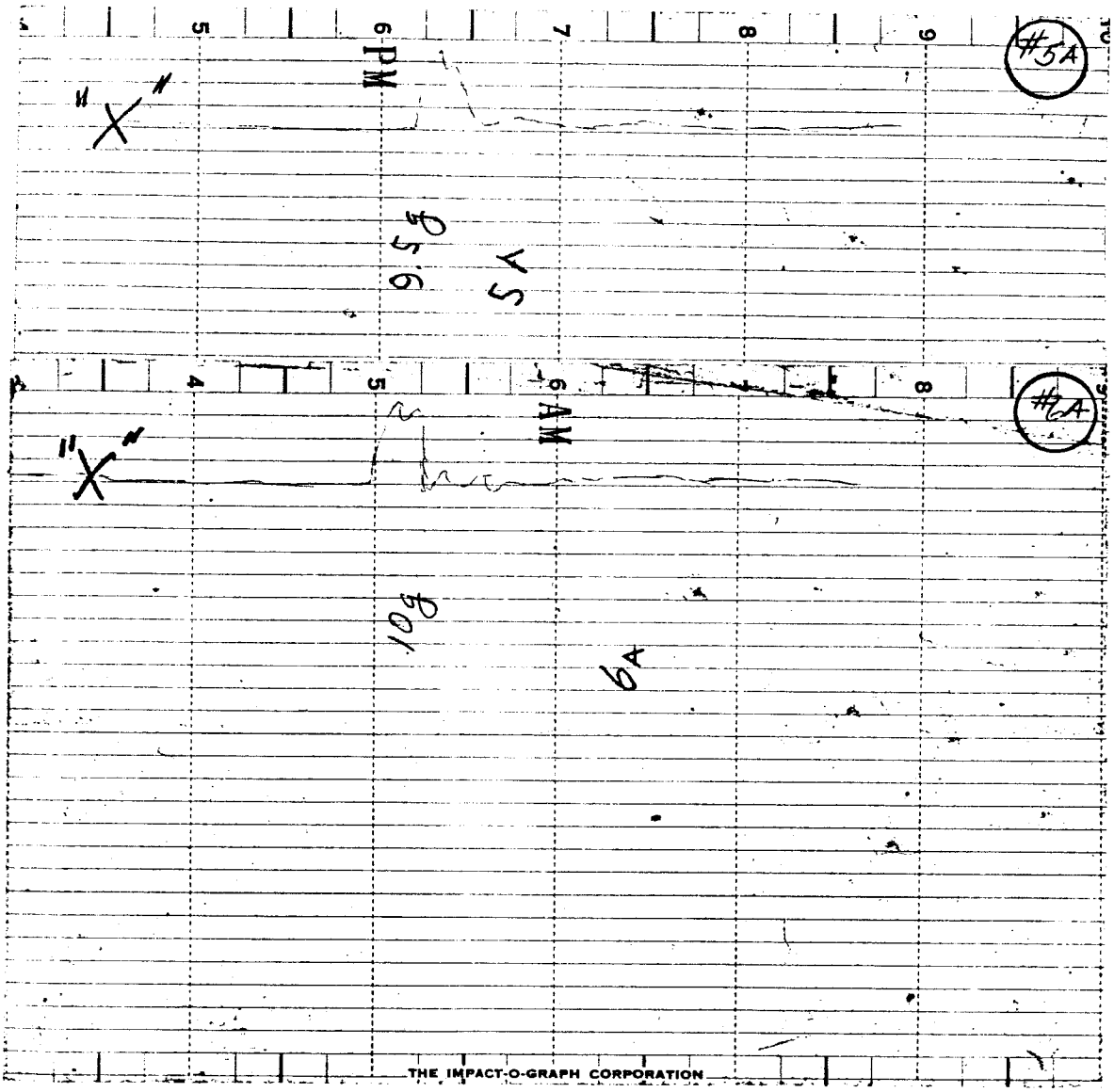
TEST #5A

DESCRIPTION: 6" diameter light duty vinyl covered duct material with helical wire wound frame capped at one end, and with a dished aluminum head of approximately 020 material. Opposite end closed, flange mounted with peripheral hole openings. Overall assembly height 13-1/8". Assembly filled with 16" of polyurethane foam filler compressed to 13". Peripheral opening 3/4" diameter, 16 places.

Configuration Same as Above

REMARKS: Good shock dissipation characteristics. Good repeatability for peak G's. G's maximum impact.

TEST #6A


#5A
PM
9.56
5A
#6A
AM
10g
6A
THE IMPACT-O-GRAPH CORPORATION

This terminal descent rate was later found to be slower than that previously calculated, thereby suggesting re-evaluation of drop altitude with the possibility of lowering the drop altitude from the presently stipulated 5400 feet.

Although the Capsule struck the ground at terminal velocity, it was found that the impact did not cause complete loss of the Capsule. This can be seen in Figure 20.

The Capsule, therefore, was sufficiently intact that an investigation could be made as to the cause of the unsuccessful test. This post test investigation revealed the time delay relay wiring error previously discussed.

Evaluation of the damage to the Dummy Capsule resulted in the decision to immediately refurbish the Dummy Capsule with new components where required, and reschedule the drop test for December 2, 1965.

Hereafter this unsuccessful drop test is referred to as Dummy Capsule Drop Test #1.

At this time, it was also decided that the Modified Recorder Capsule, Serial Number 004, be completed and tested for its drop test on the same date (December 2, 1965), as the Dummy Capsule providing the Dummy Capsule drop test is successful.

The drop tests rescheduled for December 2, 1965 were not performed due to inclement weather consisting of intermittent rain, low ceiling, low visibility. The drop tests were postponed to December 3, 1965.

On the afternoon of December 3, 1965, the tests were again staged at the Caddo Mills air strip.

During the interval from November 30, 1965 to December 3, 1965, it was determined that the drop or release altitude be lowered from 5400 feet to 4200 feet. This altitude change was based on the average

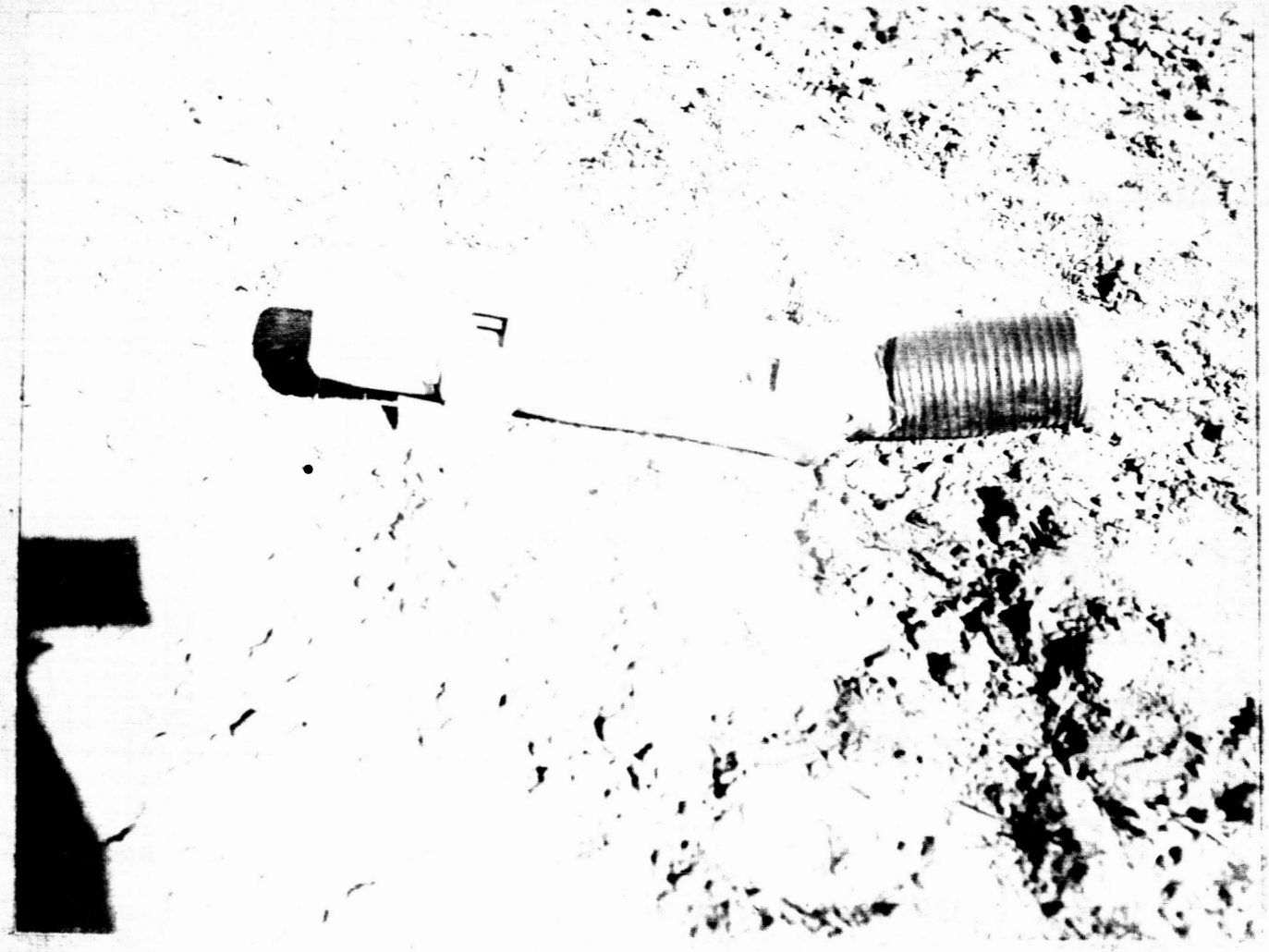


FIGURE 20

DUMMY RECORDER CAPSULE
TEST DROP #1 IMPACT RESULTS

free fall velocity of the Dummy Capsule obtained during the unsuccessful November 30 test drop. It was anticipated that this altitude change to 4200 feet, would cause the Dummy Capsule parachute system to deploy at the desired altitude of approximately 1800 feet.

Test drop for the Dummy Recorder Capsule was performed in accordance with SPACE Corp. Document 2101-T1 "Test Drop Procedure and Results, for Dummy Recorder Capsule P/N 2101-100", except that the drop or release altitude was 4200 feet.

See Appendix B for SPACE Corp. Document 2101-T1.

Various tumbling attitudes of the Dummy Capsule were observed prior to parachute deployment verifying the observed attitudes of the Capsule during Test #1 unsuccessful terminal descent.

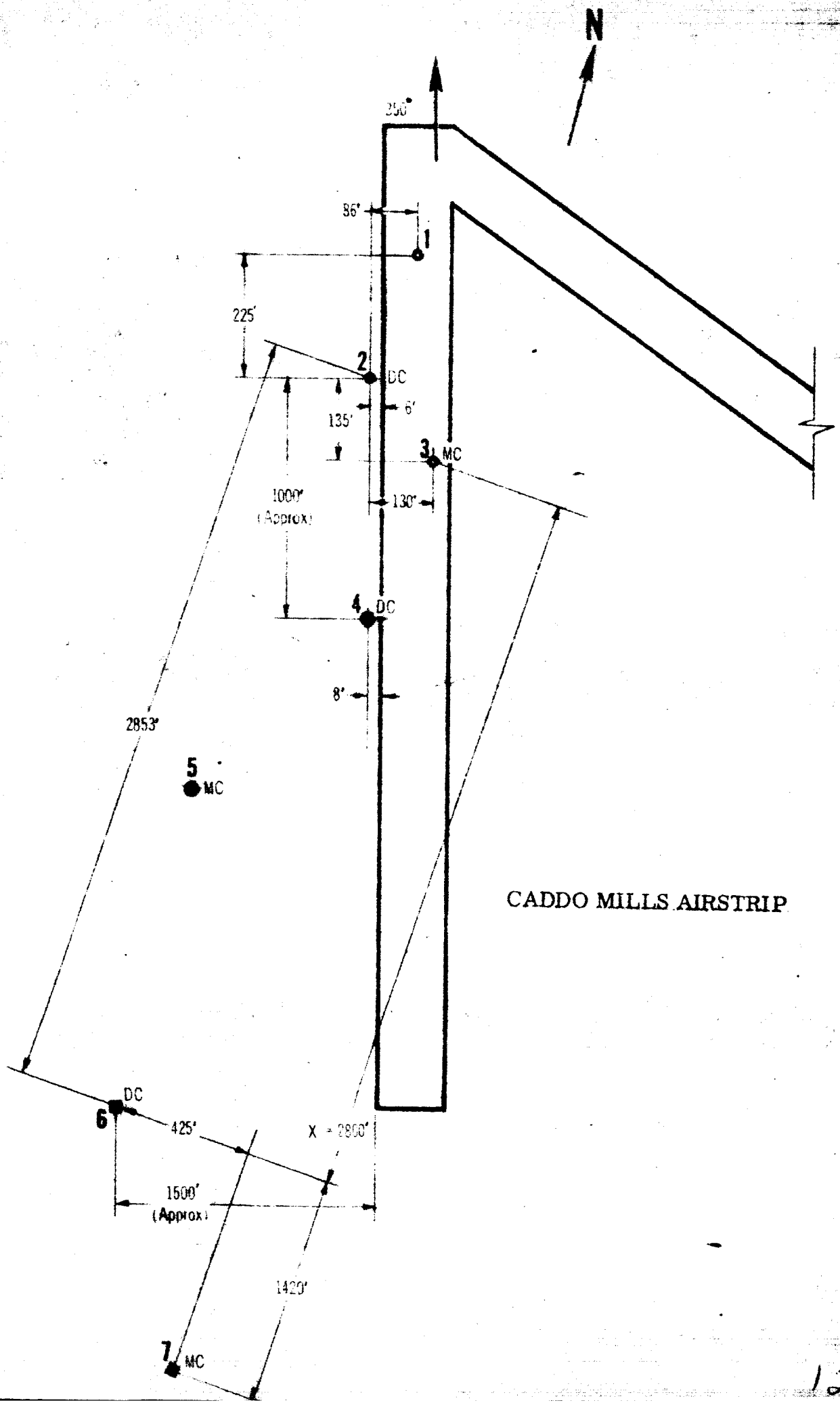
Parachute deployment appeared to be instantaneous and without fouling. Oscillations were nominal; appeared to be well within the characteristics of the Guide Surface Parachute Assembly configuration.

Drift rate was commensurate with the wind profile existing at the drop test location. See Figure 21.

Figure 21 also shows the impact location at the Caddo Mills air strip for Dummy Capsule Drop Test #2 as location #6 relative to flour sack marker position #2, both from a drop or release altitude of 4200 feet.

Figure 22 shows the attitude of the Dummy Capsule and its parachute canopy following impact.

The observed impact revealed that the drift rate was sufficient to prevent perpendicular impact of the nose cone with the ground. Lateral momentum caused the Capsule to fall sideways after impact and be further toppled by the still billowing parachute immediately prior to its collapse. Figure 23 shows the observed sequence and Figure 24 shows the impact point, the imprint of the toppled Capsule and its nose cone, and the final position of the Capsule with respect to the impact point.



CADDO MILLS AIRSTRIP

LEGEND

1. Flour sack dropped from 2000 ft.
2. Flour sack dropped w/dummy capsule at 4200 ft.
3. Flour sack dropped w/modified capsule from 4200 ft.
4. Parachute cover from dummy capsule.
5. Parachute cover from modified capsule.
6. Impact of dummy capsule.
7. Impact of modified capsule.

DC = dummy capsule
MC = modified capsule

WIND PROFILE

ALTITUDE - FT	DIRECTION - DEG	VELOCITY - MPH
0	330	6.25
1000	330	23.0
2000	15	23.0
3000	15	23.0
4000	15	23.0

NOTE:

1. Dummy Capsule Drift Distance = Dd = 2853 ft.
2. Modified Capsule Drift Distance = Dm = X + 1420 = 4220 ft.
3. Except for those shown as "approx.", distances shown are measured distances.

Impact Locations for Test Drops
(Dummy and Modified Capsules)

Figure 21

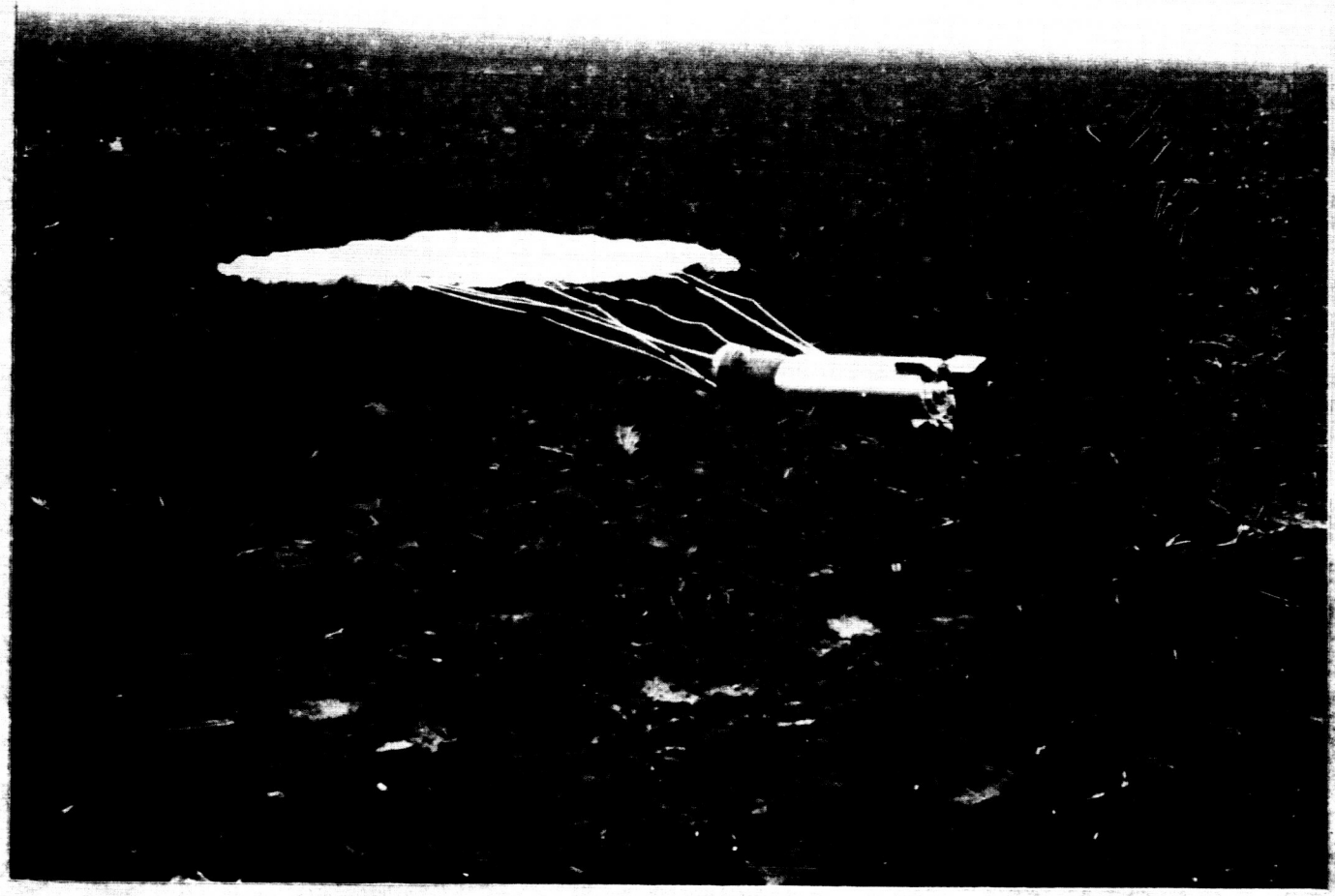
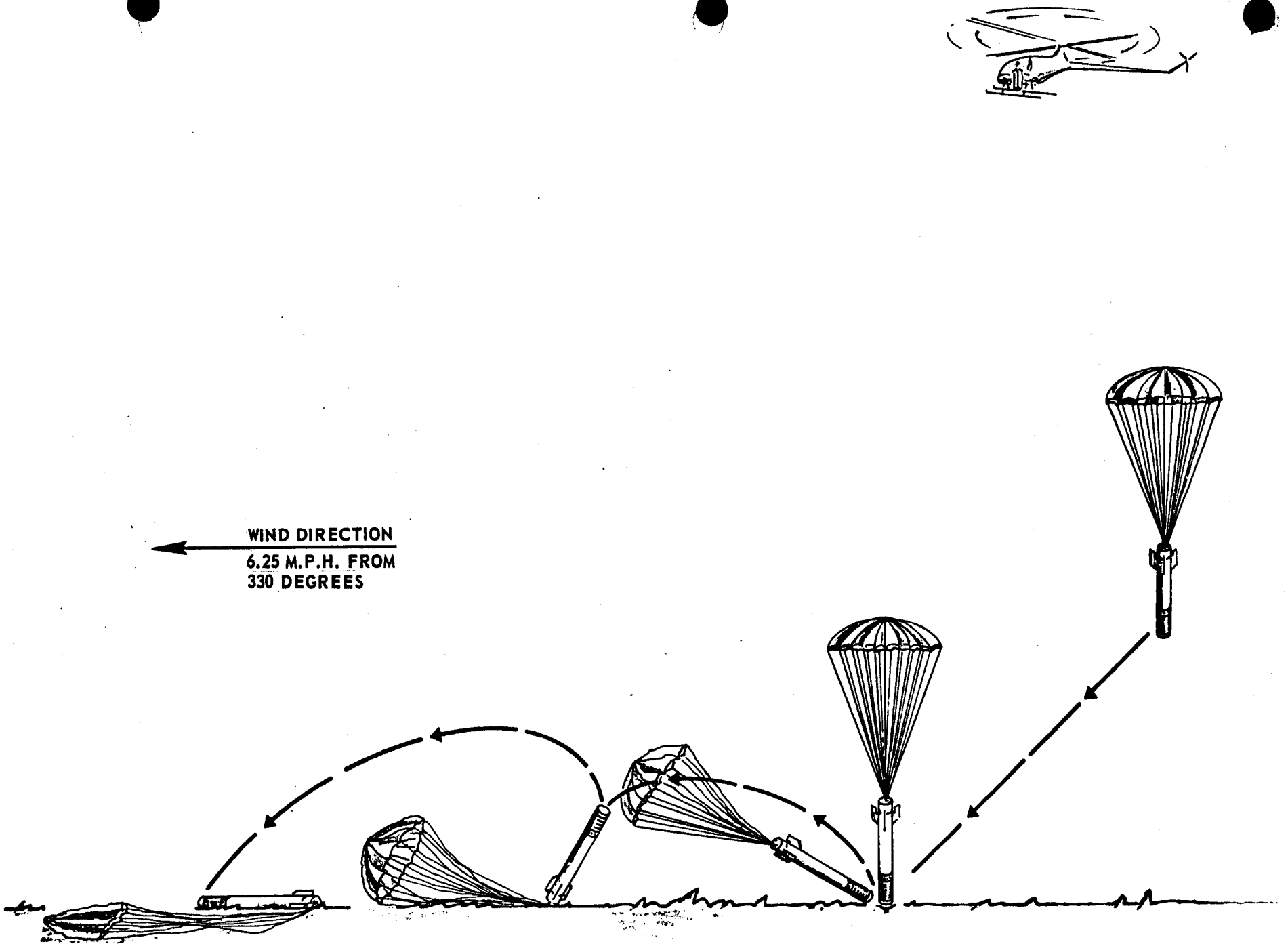


FIGURE 22

DUMMY RECORDER CAPSULE TEST #2



IMPACT ATTITUDE SEQUENCE FOR DUMMY CAPSULE DUE TO EFFECT OF DRIFT
FIGURE 23

FIGURE 24

DUMMY RECORDER CAPSULE
ASSEMBLY AND IMPACT POINT

Figure 25 shows the recovered parachute cover for the Dummy and Modified Capsules; the Dummy Capsule on the left and Modified Capsule on the right. These covers shown are "as recovered". It is assumed the distortion occurred upon impact with the ground. It is not intended that these covers be recovered in the actual use of the Capsules.

Evaluation of the strip chart data in the Dummy Capsule revealed that the assembly had not been subjected to more than 10 G's impact. See Figures 27, 28, 29, 30, 31 and 32. These figures are extracted sections from the total strip chart showing events pertinent to the desired results for the Capsule Assembly, as shown on Figure 26. In Figure 32 it can be seen that actual magnitude was 8.2 G's in one direction of the "X" axis (vertical) and 8.0 G's in the opposite direction. Such reversal of the impact direction was due to the impact attitude of the capsule due to the considerable drift rate caused by the prevailing surface wind profile at the time of the test.

From Figure 32 it can also be seen that because of the drift rate of the descending Capsule Assembly, toppling of the assembly and the added action of the not as yet collapsed parachute caused the Capsule to somersault and impact the ground from the end opposite to the nose cone. This impact, as can be seen, exceeded 10 G's slightly (10.9). However, examination of the Dummy Capsule revealed that the unit was still operable with the Impact Recorder still in operation, and the strip chart moving. Visual examination of the recovered Dummy Capsule revealed only insignificant superficial damage such as bent fins, etc.

It was considered that the Dummy Capsule successfully met the requirements for a 10 G impact for 50 milliseconds, as a maximum condition. Strip chart time base data evaluated later revealed a momentary electrical condition affecting time base only. This is discussed in Appendix G. Drift appeared to be excessive, subject to verification by calculation correlated to the specified wind profile in the Scope of Work.

Following this Dummy Capsule test drop and evaluation of the recorded and observed results, it was decided to immediately begin preparations for the drop testing of the Modified Recorder Capsule within this same date.

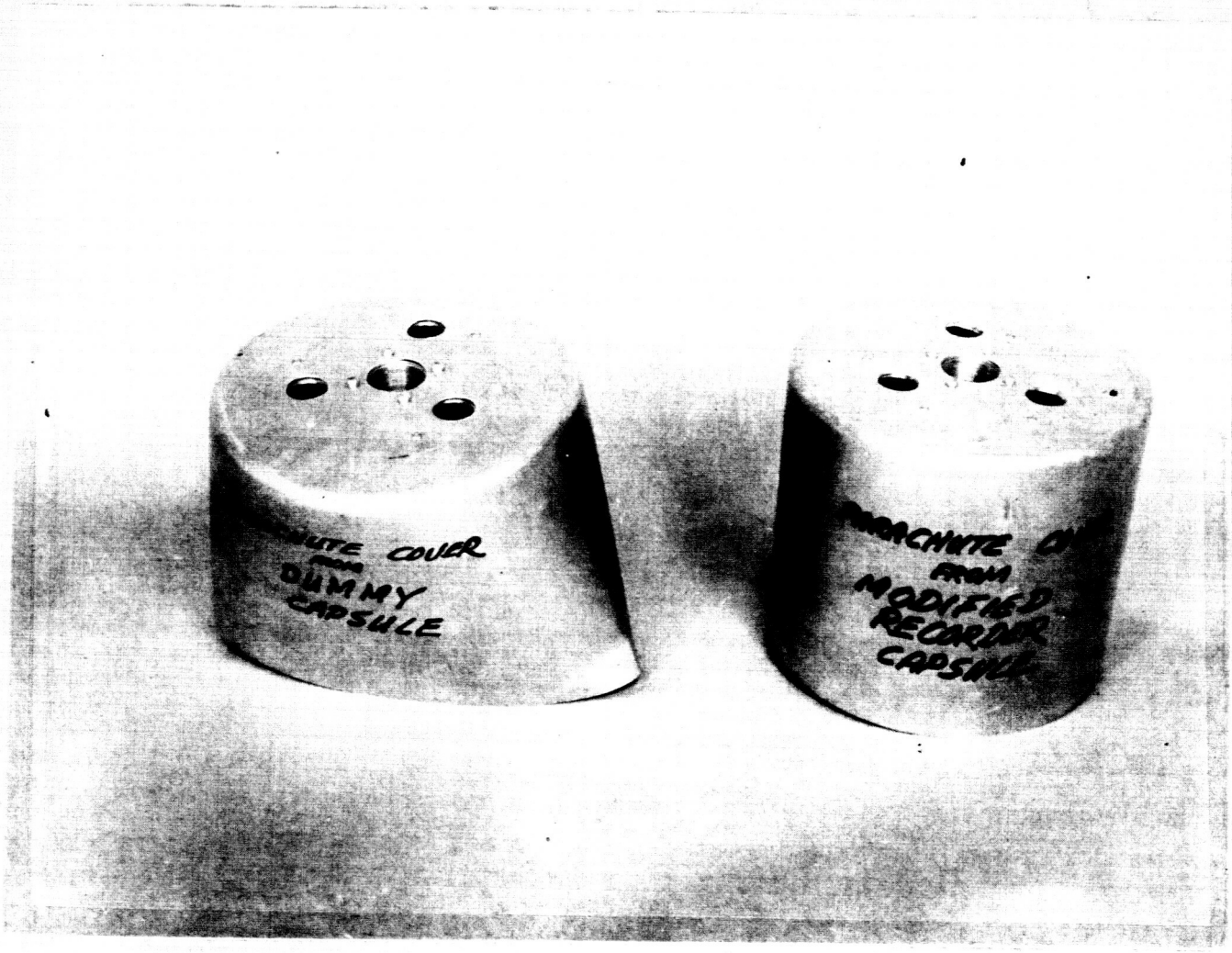
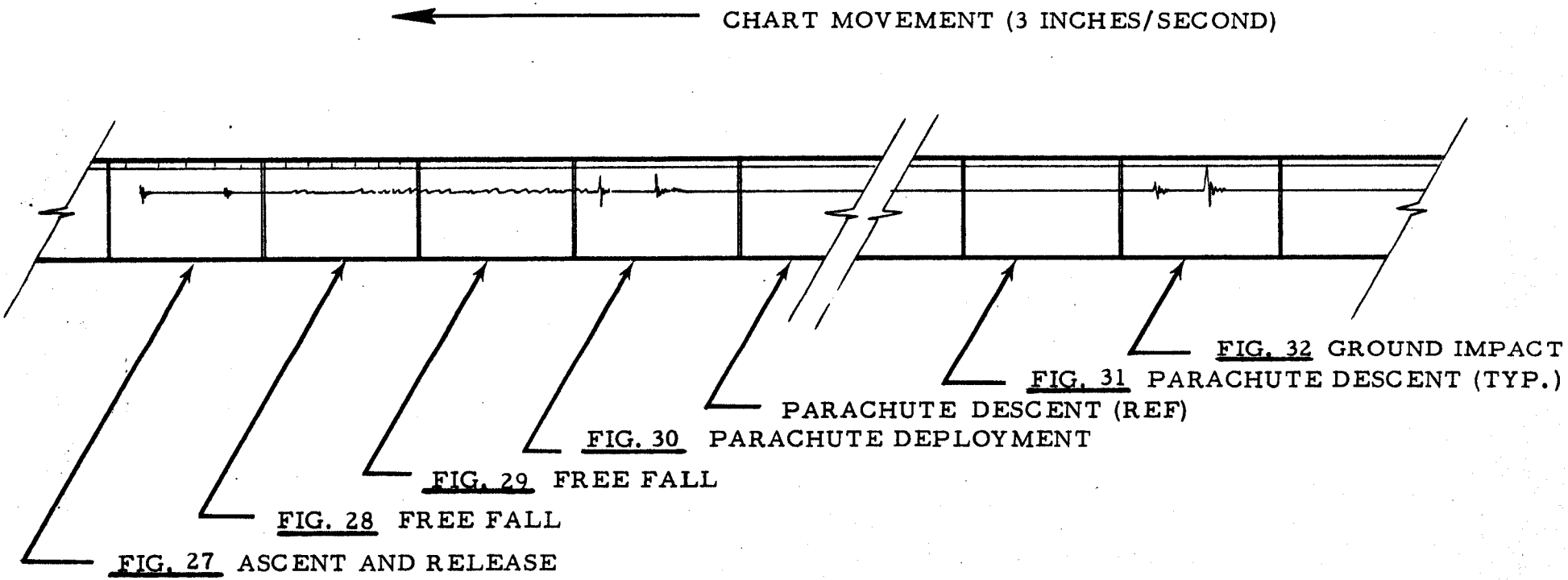


FIGURE 25

RECOVERED PARACHUTE COVERS



SEQUENCE OF EVENTS
IMPACT RECORDER CHART SEGMENTS AS RELATED TO TOTAL STRIP CHART
FIGURE 26

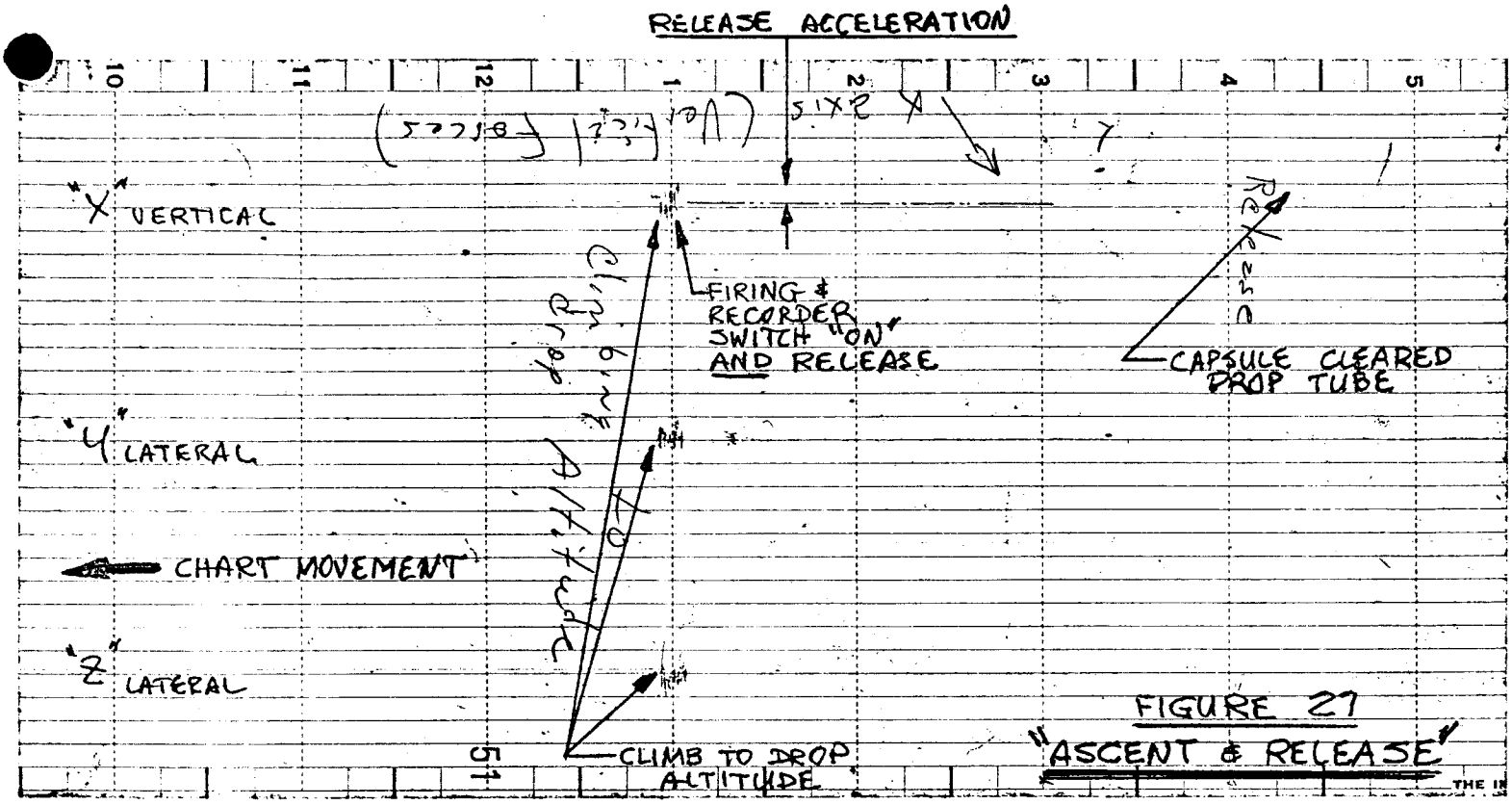


FIGURE 27
"ASCENT & RELEASE"

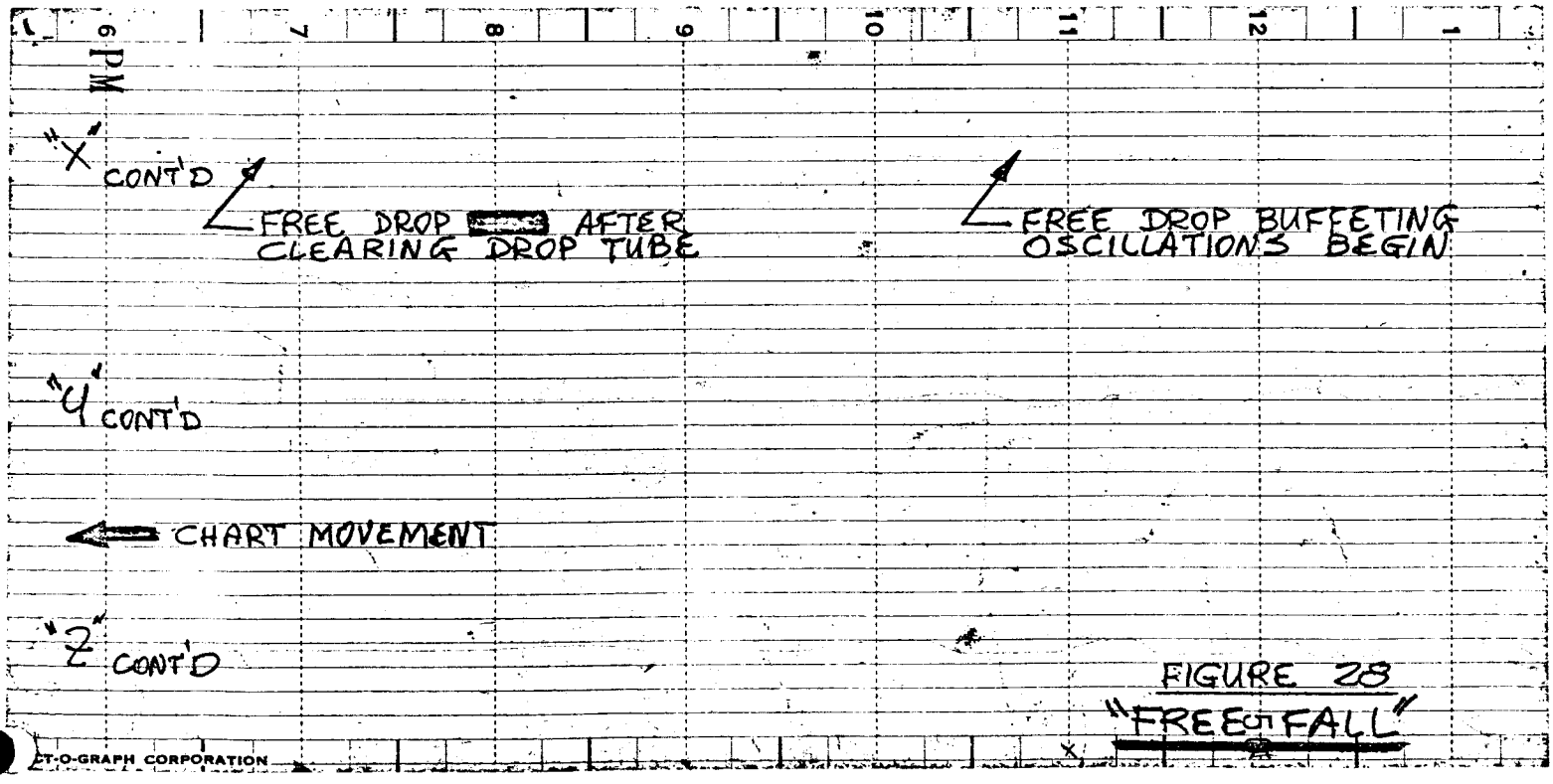


FIGURE 28
"FREE FALL"

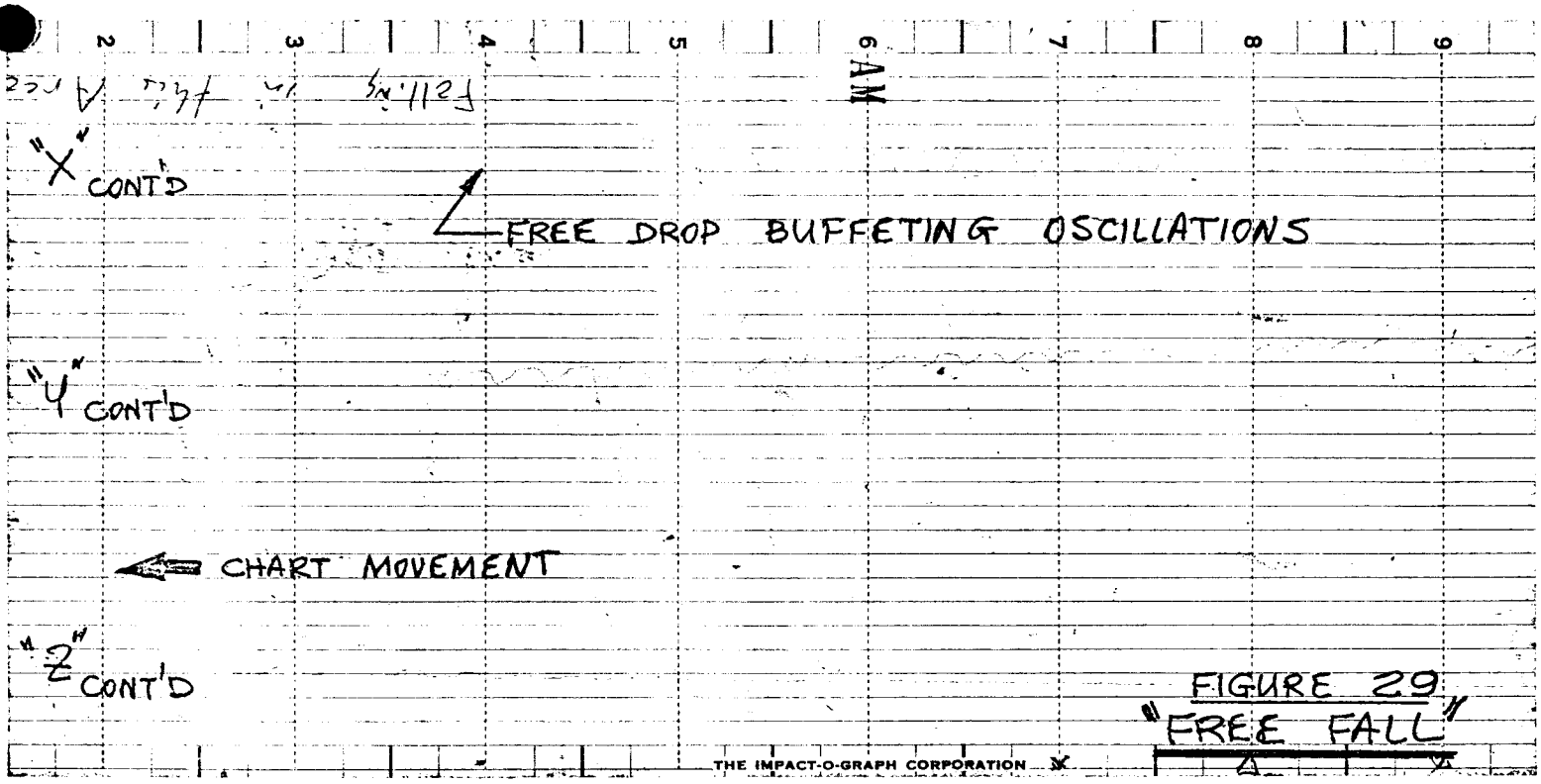
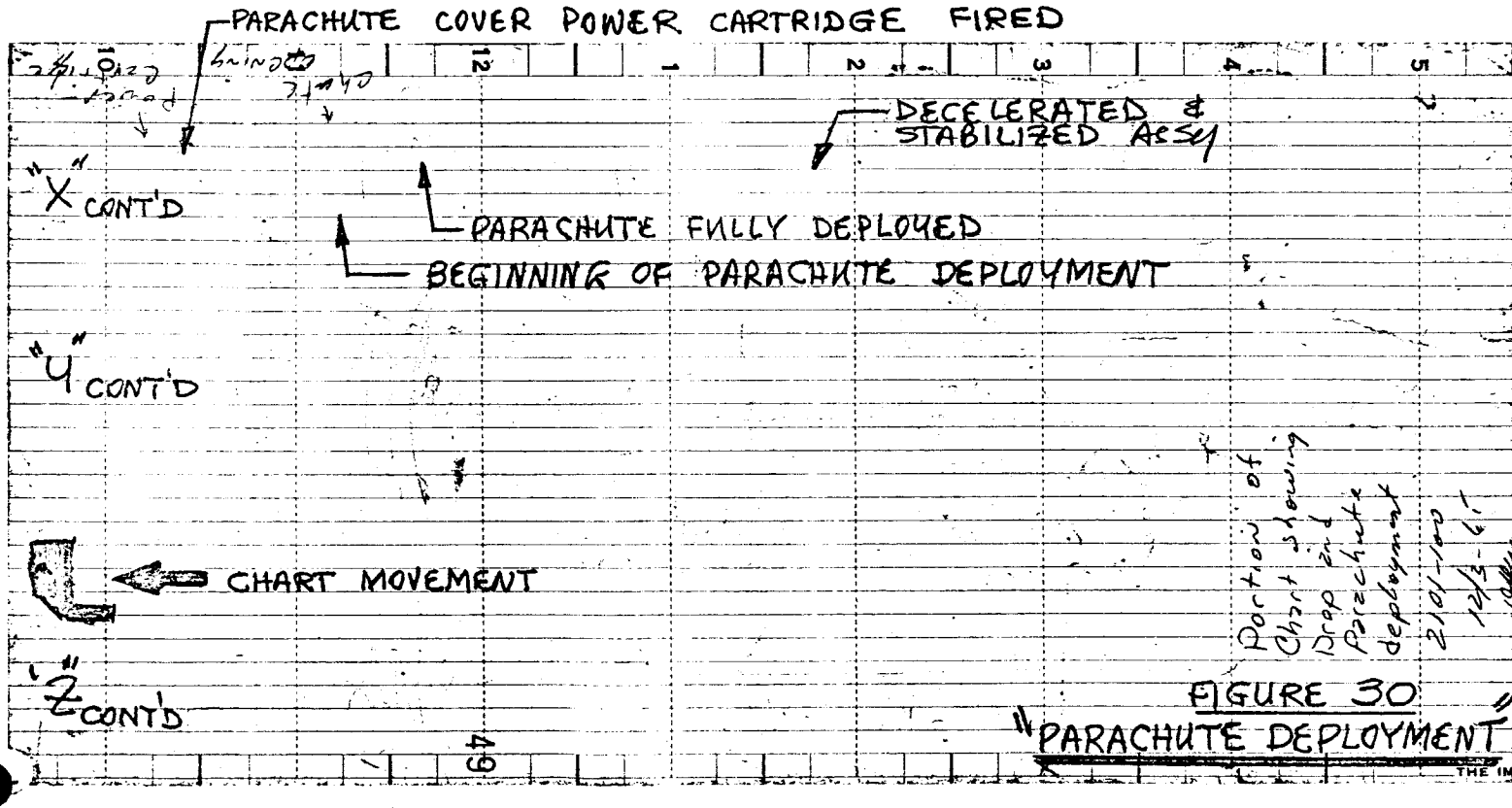


FIGURE 29
"FREE FALL"



Portion of Chart showing Drop and Parachute deployment 21 Oct 1960

FIGURE 30
"PARACHUTE DEPLOYMENT"

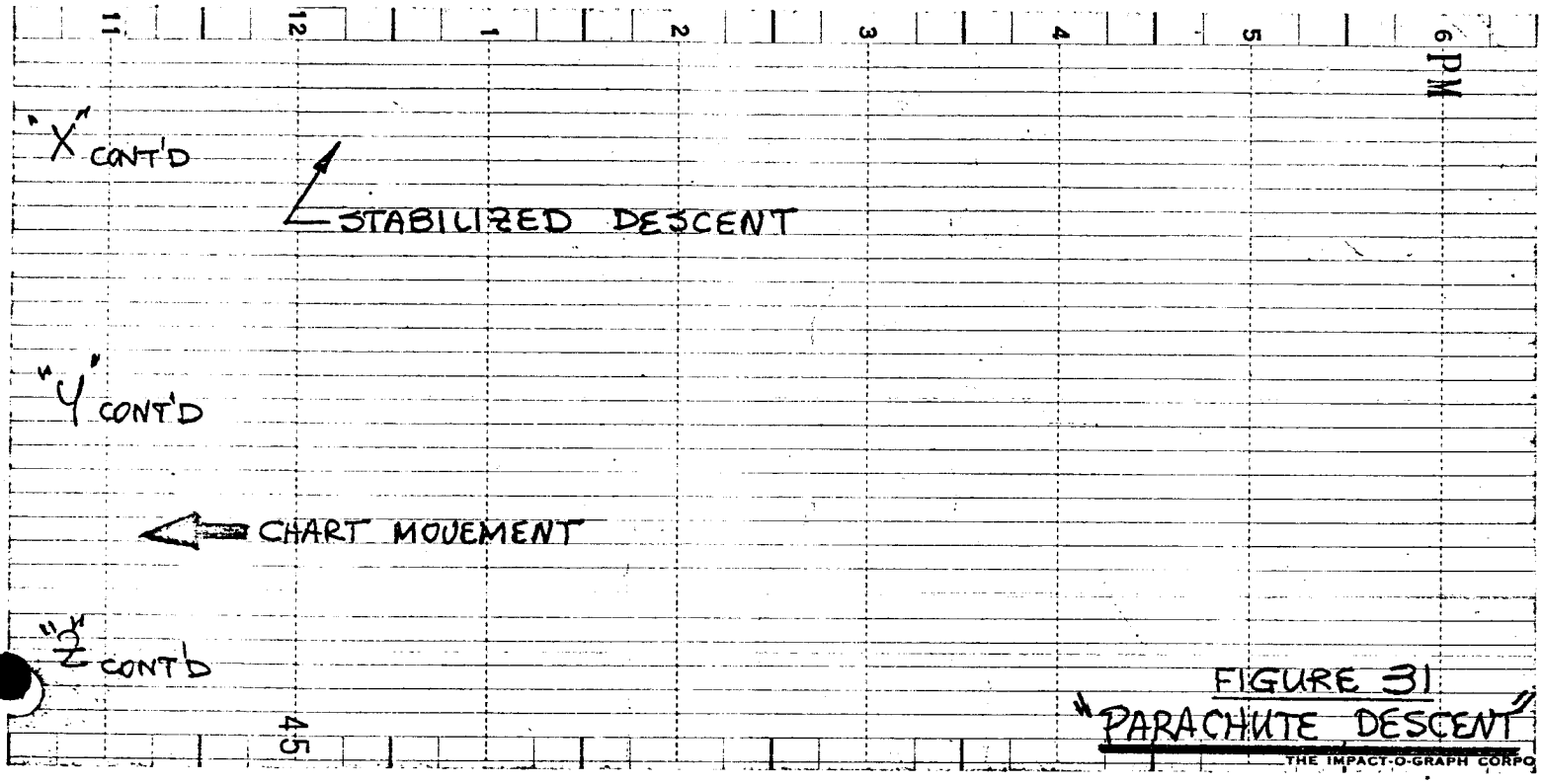


FIGURE 31
PARACHUTE DESCENT

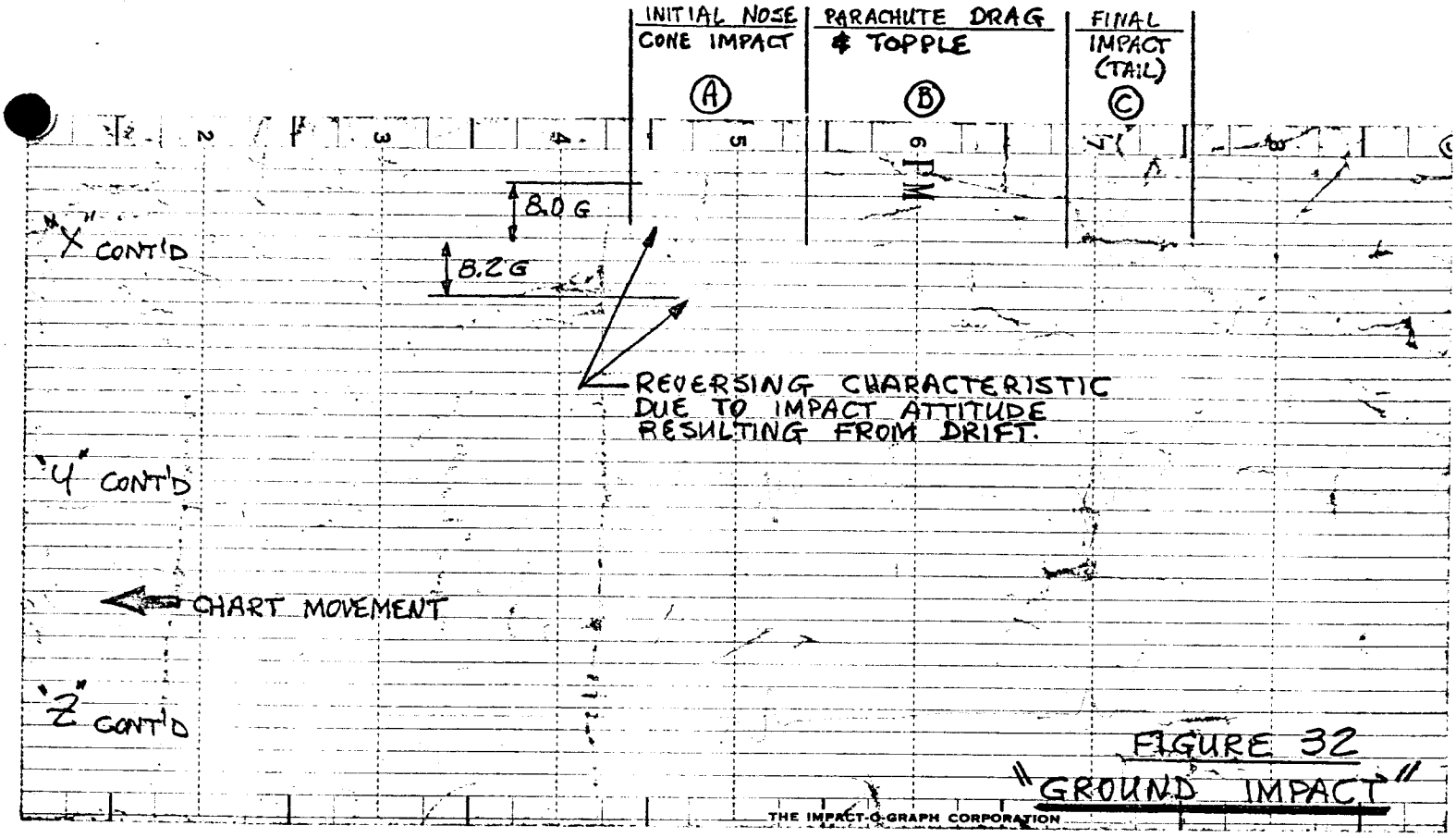


FIGURE 32
"GROUND IMPACT"

DROP TESTS - MODIFIED RECORDER CAPSULE.

Since the successful performance of the test drop for the Dummy Capsule was considered to be within the capability of the Modified Recorder because of their identity with respect to dimensions, weight, c.g. location, pyrotechnic devices, deployment system, parachute, etc. the Modified Recorder was not fitted with an impact recording device. Moreover, such a device was not considered desirable for fear of altering certain characteristics of the Modified Recorder Capsule.

Test drop for the Modified Recorder Capsule was performed this same date (December 3, 1965) in accordance with SPACE Corp. Document 2101-T2 "Test Drop Procedure and Results for Modified Recorder Capsule P/N 2101-200", except that the drop or release altitude was 4200 feet.

See Appendix C for SPACE Corp. Document 2101-T2.

Figure 35 shows the schematic diagram for the control/arm circuit as existing on the Modified Capsule and the external power supply utilized through Plug #P16 for initiating the required functions, such as time delay relays and thermal batteries. This external power supply to the Modified Capsule via a wiring harness was carried on board the helicopter.

It will be noted that the schematic diagram is identical to the unmodified Recorder Capsule except that the previous five second time delay switch was changed to fifteen seconds.

After loading of the Modified Capsule into the drop tube of the helicopter, the "safe" plug was removed and replaced with the "arm" plug. The P15/P16 connectors and harness assembly were inserted into the Capsule receptacle. The 24 V DC battery power supply was placed on the floor of the helicopter with the firing switch "OFF".

At drop or release altitude, the Modified Capsule release was immediately preceded with a five pound flour sack drop. The firing switch was placed to the "ON" position, the P15/P16 connector and harness assembly were removed, and the Capsule release pin removed, releasing the Capsule.

Parachute deployment was observed to be instantaneous, with very little oscillation of the assembly. Stability appeared to be better than that observed on the Dummy Capsule Drop Test #2.

Drift rate was in proportion to the wind profile existing at the drop test location. See Figure 21. Figure 21 also shows the impact location at the Caddo Mills air strip for the Modified Recorder Drop Test as location #7 relative to flour sack marked position #3, both from a drop or release altitude of 4200 feet.

Observed tumbling attitudes of the Modified Capsule during free fall did not appear to be as pronounced as for the Dummy Capsule.

Figures 33 and 34 show the attitude of the Modified Capsule and its parachute canopy following impact.

Impact as observed and cerified by Reels A and B of the movie film was essentially as theoretically intended. In spite of the horizontal drift rate of the assembly, impact attitude appeared to permit performance of the nose cone as desired. After collapse of the nose cone, the assembly was not dragged, but toppled by its own weight within its own length with the parachute gently collapsing to one side away from the Capsule. See Figure 33.

Damage to the Capsule was limited solely to a bent tail fin which was easily corrected. Condition of the nose cone was such that it is to be considered a reusable component.

By virtue of the observed impact and the data derived from the preceding Dummy Capsule Test Drop #2, it is considered that the Modified Recorder Test was successful in meeting the requirement

of the Statement of Work. In view of the wind profile existing for the day of test and the deployment altitude variation from that desired, certain interpolations are required to establish that the Modified Recorder Capsule did meet the shock mitigation requirements of 10 G's for 50 milliseconds, maximum conditions.

It should be noted that no distance measurements were taken on the day of the drop tests (December 3, 1965). However, on Monday, December 6, 1965 a team of two engineering personnel returned to the Caddo Mills drop site to physically measure the distances shown on Figure 21.

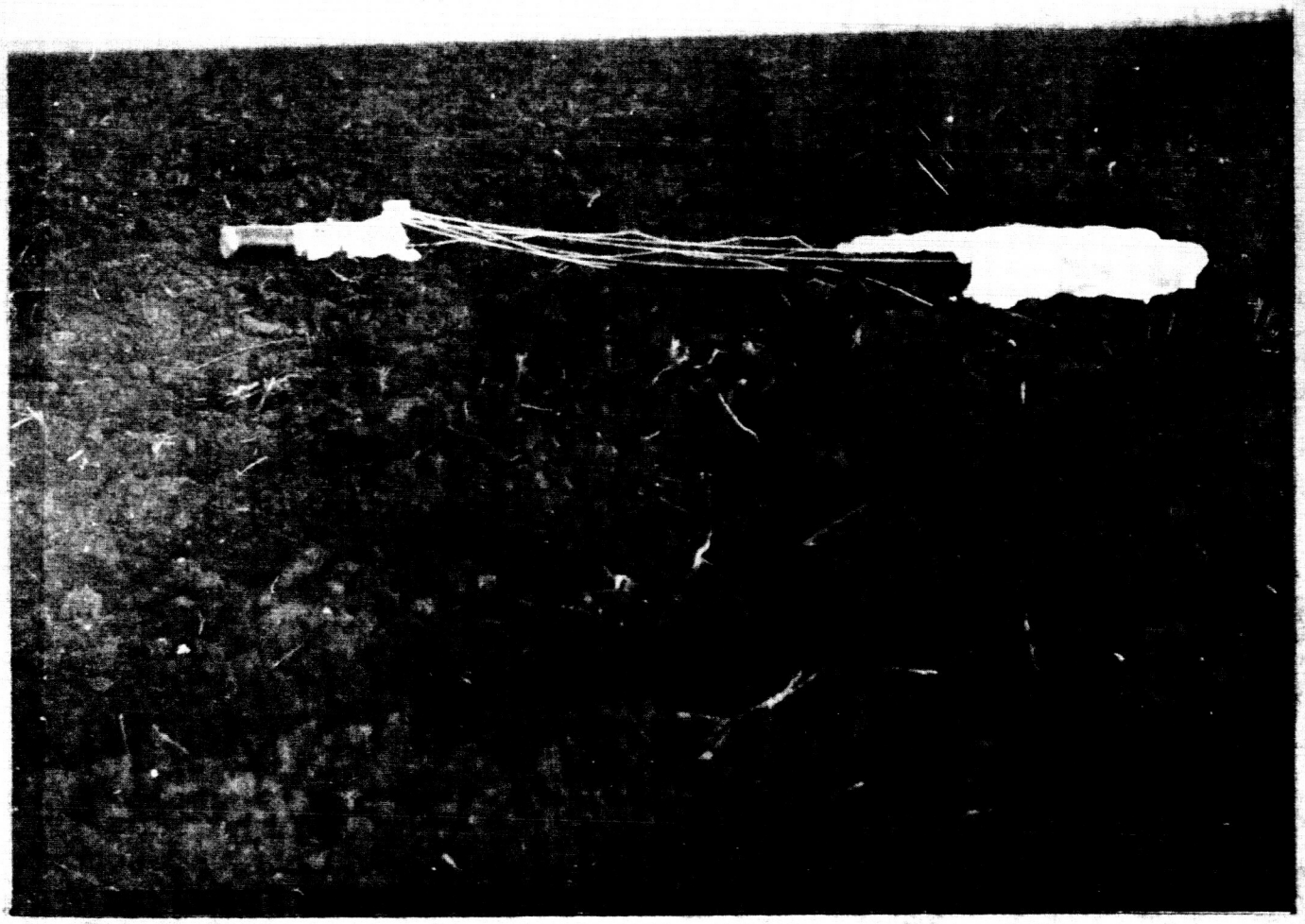


FIGURE 33

MODIFIED RECORDER CAPSULE ASSEMBLY

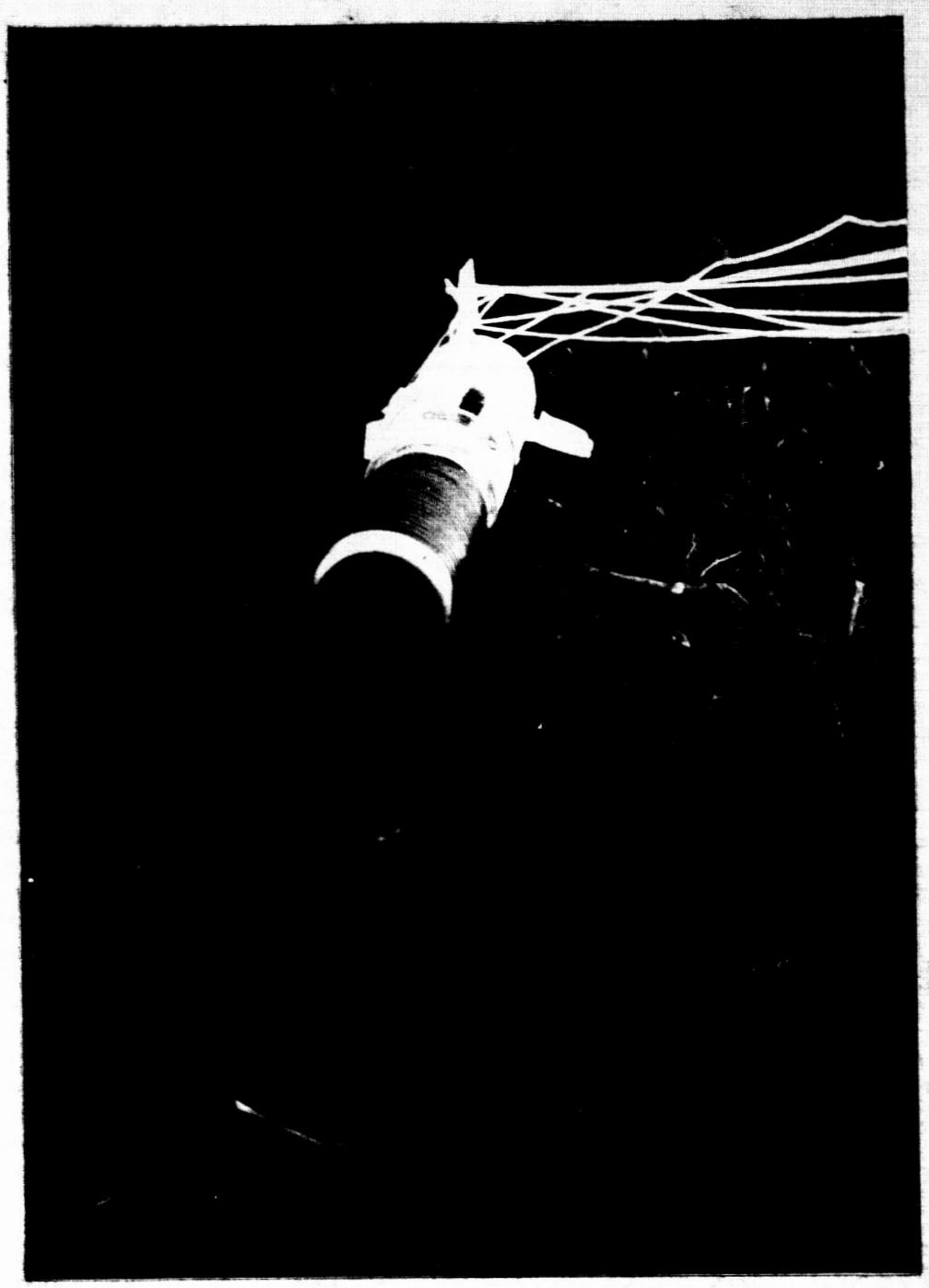
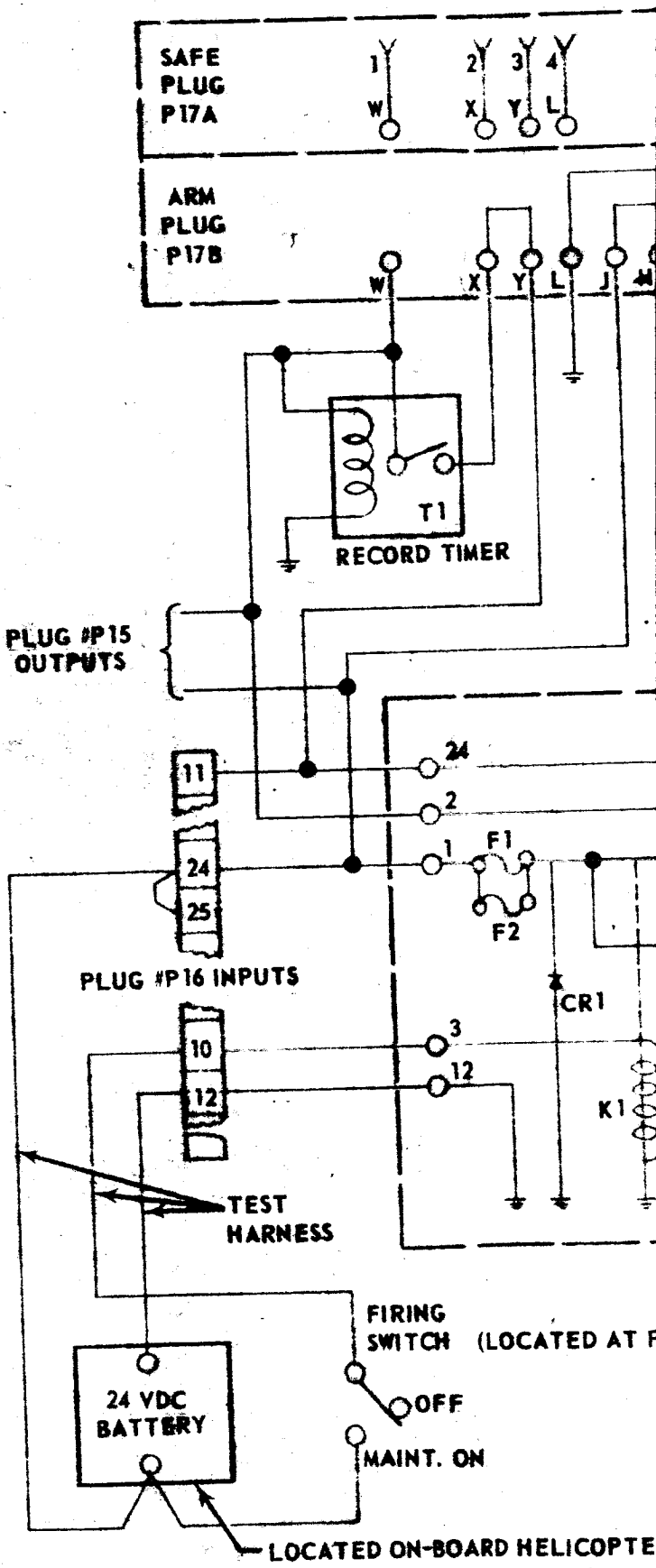
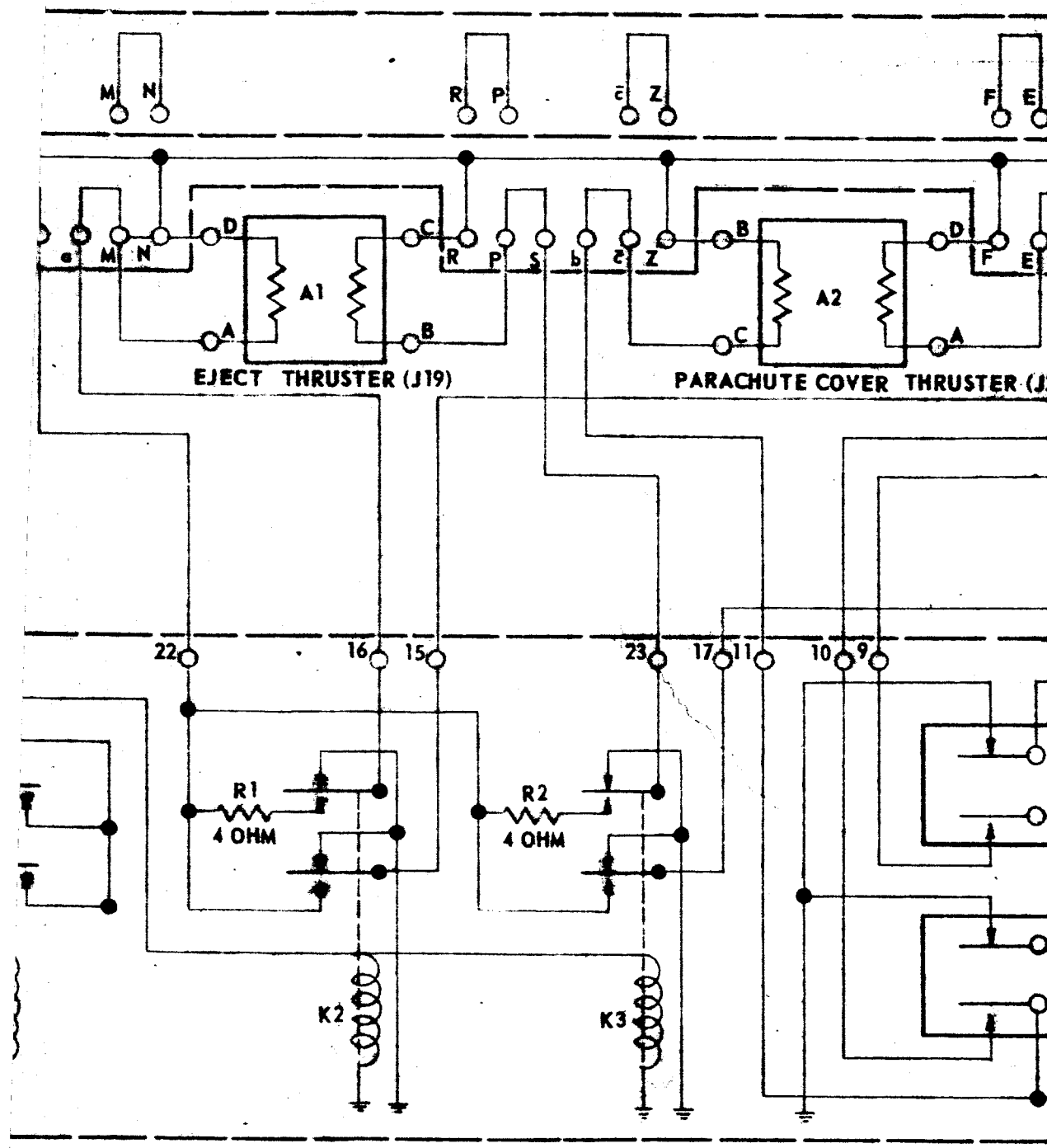


FIGURE 34

MODIFIED RECORDER CAPSULE ASSEMBLY


SAFE PLUG P17A
1
2
3
4
W
X
Y
L
ARM PLUG P17B
W
X
Y
L
J
T1
RECORD TIMER
PLUG #P15 OUTPUTS
11
24
2
24
25
1
F1
F2
PLUG #P16 INPUTS
CR1
10
12
3
12
K1
TEST HARNESS
FIRING SWITCH (LOCATED AT F
24 VDC BATTERY
OFF
MAINT. ON
LOCATED ON-BOARD HELICOPTE

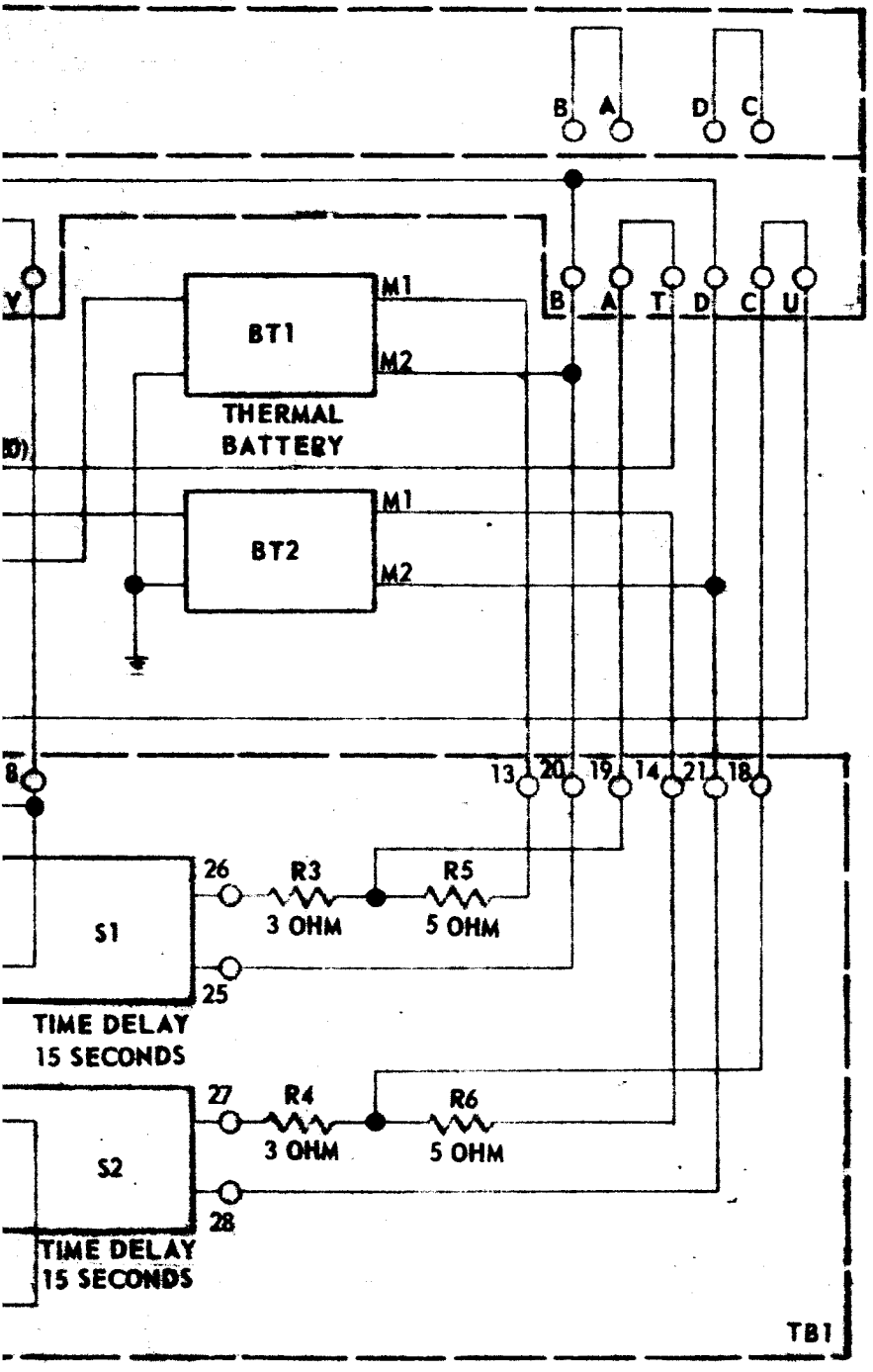


OWER SUPPLY)

R

C

140-2

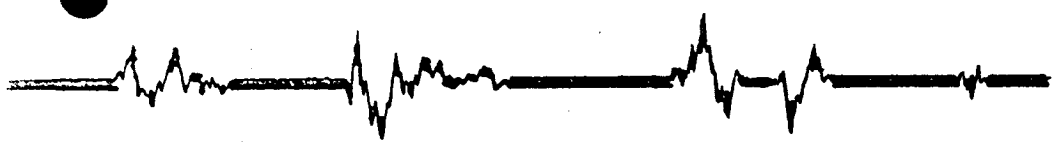


SCHEMATIC DIAGRAM
NTROL/ARM & POWER SUPPLY

FIGURE 35

APPENDIX A

CERTIFICATIONS



The Impact-O-Graph CORPORATION

August 13, 1965

CERTIFICATION STATEMENT

We hereby certify that the 15X,6Y,6Z stylus bracket shipped under your Purchase Order No. 48305 has been inspected for compliance with the detail engineering design requirements and will function in accordance with the calibration chart furnished therewith to an accuracy of within ten per cent at full scale.

THE IMPACT-O-GRAPH CORP.

By R. F. Warner (R.C.)
R. F. Warner,
Vice President, Engineering

To: Space Corporation
Box 5175
Dallas, Texas

1762 East 18th Street
Cleveland, Ohio 44114
AC 216—241-5838

15 X 15 X 15

THE IMPACT-O-GRAPH CORPORATION
1762 East 18th St.
Cleveland, Ohio

CALIBRATION TABLE FOR 15g SENSITIVITY

"g" Tables Acceleration

(Read From Center Line)

Inches	Spaces	"g"
1/8	1	2.7
1/4	2	5.5
3/8	3	8.2
1/2	4	10.9
5/8	5	13.6
6/8	6	16.3

(Read Full Swing of Arc)

Inches	Spaces	"g"
1/8	1	1.6
1/4	2	3.2
3/8	3	4.8
1/2	4	6.4
5/8	5	8.0
6/8	6	9.6
7/8	7	11.2
1	8	12.8
1-1/8	9	14.4

DYNAMIC TABLE

(Full Swing)

VELOCITY

Reading Spaces	Ft./Sec.	Mi./Hr.	Drop Height Inches
1	.42	.285	.033
2	.85	.580	.135
3	1.27	.860	.300
4	1.70	1.15	.540
5	2.12	1.45	.840
6	2.52	1.72	1.18
7	2.93	2.00	1.60
8	3.35	2.28	2.10

ORIGINAL

TABLE B

APPENDIX B

SPACE CORP. DOCUMENT 2101-T1

"TEST DROP PROCEDURE AND RESULTS
FOR
DUMMY RECORDER CAPSULE P/N 2101-100"

TEST DROP PROCEDURE

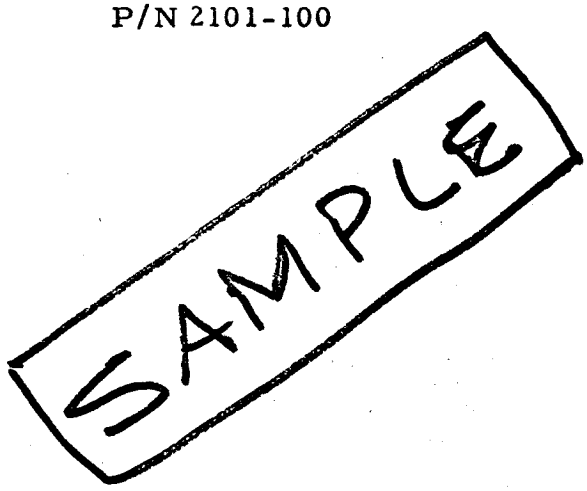
AND

RESULTS

FOR

DUMMY RECORDER CAPSULE

P/N 2101-100



DOCUMENT:	2101-T1
PREPARED BY:	SPACE CORP. Dallas, Texas
SPACE CORP. JOB NO:	2101
NASA CONTRACT:	NAS8-11819

TABLE OF CONTENTS

TEST DROP PROCEDURES AND RESULTS
FOR DUMMY RECORDER CAPSULE

I. PURPOSE OF TEST

This Dummy Recorder Capsule test is to be performed to assure that modifications made to the Recorder Capsules as specified in Contract NAS8-11819 are adequate to prevent undue damage to the Capsule during descent and impact after ejection from a parent missile. This test is for the Dummy Recorder Capsule dropped from an altitude to simulate only the time interval to be experienced by the Modified Recorder Capsule and impact results.

TEST DROP PROCEDURES AND RESULTS
FOR DUMMY RECORDER CAPSULE

II. DROP SITE

The test drop will be performed at the unused emergency airfield at Caddo Mills, Texas.

TEST DROP PROCEDURES AND RESULTS
FOR DUMMY RECORDER CAPSULE

III. NOTIFICATION TO FAA

Eight (8) hours advance notice must be given to the local FAA office of the test drop.

IV. TEST CONDITIONS - WEATHER

The test drop will not be made under adverse weather conditions that impair safety, vision or the performance of certain check functions. It is preferred that nearly ideal weather conditions exist for the test drop. Rainy or misty weather that impairs visibility, safety, and photographic coverage are considered adverse conditions. Winds, steady or gusty, in excess of 10 mph are also considered adverse conditions; however, desirable wind conditions for drop up to 10 mph will be evaluated by the test engineer.

V. TEST PROCEDURE CHANGES

It will be the test engineer's responsibility and privilege to alter any part of the test procedure as required by immediate unforeseen problems or circumstances insofar as these deviations or changes do not detract from the overall intent of the test. It will also be his privilege and responsibility to stop or abort parts of the test or the total test if conditions are such that personnel and/or test item safety are in question.

VI. TEST EQUIPMENT

Helicopter

Binoculars

Stop Watch

Movie Camera

100 ft. Surveyor's tape and stakes

Machinist's Scale

Thermometer

Velometer

Arming Plug, P/N 2101-101-4

1 Pound Sack of Flour

Hand Tools

Large, Hard-Surface Clearing for drop site.

Radio for contact with helicopter.

VII. PERSONNEL REQUIRED

Helicopter Pilot

Helicopter Passenger

Vehicle Driver and Radio Operator

Cameraman

Observer (Binoculars)

Observer (Stop Watch)

TEST DROP PROCEDURES AND RESULTS
FOR DUMMY RECORDER CAPSULE

VIII. TEST METHOD

Assemble the following equipment to be put aboard the helicopter:

a. Flour Sack (Marker)

b. Arming Plug (Red)

c. Test Item (Dummy Recorder Capsule)

All other equipment shall be assembled at drop site.

Prior to boarding the helicopter, insert the Arming Plug into the Test Item to determine if there is any malfunction.

CAUTION:

DO NOT TURN SWITCH ON!

Remove the Arming Plug and mount Test Item into drop tube assembly on the helicopter. Place flour sack marker in helicopter.

Insert the Arming Plug into the Test Item.

CAUTION:

DO NOT TURN SWITCH ON!

TEST DROP PROCEDURES AND RESULTS
FOR DUMMY RECORDER CAPSULE

Make certain the Test Item is clocked in the drop tube for access to the ON-OFF Switch.

The helicopter will proceed to an altitude of approximately 5435 feet and hover at the up-wind edge of the drop site. The cameraman will be approximately 800 feet down wind from the expected drop area of the flour sack. When it is determined that the ground crew is ready, the helicopter shall remain as close as possible to the correct altitude and preparation for the drop will be made. The flour sack will be dropped and within approximately two (2) seconds, the toggle switch of the Test Item will be actuated to "ON" and the Test Item dropped. The actual instant of drop will be conveyed to the ground and the stop watch will be started. The drop altitude will be relayed and recorded. At the instant of parachute deployment, the time will be recorded, as also will be the moment of impact with the ground.

The cameraman will take pictures of the parachute descent (to evaluate the oscillation characteristics), the impact, and

other photographs after impact as required to evaluate any damage that may have occurred and to record the actual impact surface.

After impact, a measurement to the nearest foot and in approximately a straight line, will be made from the point of impact of the flour sack to the point of the test item and recorded.

The binoculars will be used to observe all phases of the drop and information from this source will be entered in "comments" on the Data Sheet.

All above data will be recorded on Data Sheets No. 1 and No. 2.

TEST DROP PROCEDURES AND RESULTS
FOR DUMMY RECORDER CAPSULE

IX. DATA AND TEST EVALUATION

SEE APPENDIX D & E

TEST PROCEDURE 2101-T1

DATA SHEET NO. 1

DATE: _____

TIME: _____

Surface Wind (MPH) . . . . . _____

Barometric Pressure (In. Hg.) . . . . . _____

Temperature (^{o}F) . . . . . _____

Drop Height (Helicopter Altitude) . . . . . _____

Time from Drop to Deployment (sec.) . . . . . _____

Time from Drop to Impact (sec.) . . . . . _____

Distance from flour marker impact to Test Item impact (feet) . . . . . _____

SEE APPENDIX D & E

COMMENTS: _____

_____

Test Engineer _____

TEST PROCEDURE 2101-T1

DATA SHEET NO. 1
(Page 2)

Data Evaluation:

Successful completion of the test requires that deployment be successful and that drift, under wind conditions in Appendix "A" of the contract, shall not exceed 1000 feet.

If the measured distance of drift is in excess of 1000 feet, this shall be corrected by use of the Chart of Appendix "A" of the contract, the time of deployed descent, and with the surface wind as a constant for this time.

If this correction is required, the calculations shall be appended to this sheet and noted below:

		Yes	No
A.	Deployment Successful	_____	_____
B.	Drift Less Than 1000 Feet	_____	_____
C.	Drift Calculations Included	_____	_____

WITNESSES:

	Name	Organization	Title
1.			
2.			
3.			
4.			
5.			

TEST PROCEDURE 2101-T1

DATA SHEET NO. 2

IMPACT LOADING:

Remove the strip chart from the impact recording instrument and record the following information:

1. Maximum Stylus deflection — Chart Lines (To the nearest 1/2 line)

X	_____
Y	_____
Z	_____

2. Convert the "Chart Lines" to equivalent g's by use of Impact-O-Graph Calibration Tables B and C as applicable.

Stylus	Maximum "g's"
X	_____
Y	_____
Z	_____

3. Determine horizontal distance that X Sytlus was equal to or above 10 g's value in 32nd of an inch.

Distance (equal to or above 10 g) for X stylus _____ 32nd inch.

SEE APPENDIX D & E

TEST PROCEDURE 2101-T1

DATA SHEET NO. 2
(Page 2)

4. Convert distance to time by use of SPACE Corp. Chart SK 2101-4

Time equal to or above 10 g's _____ Milliseconds

Test Engineer: _____

Date: _____

Data Evaluation:

Successful completion of this portion of the test requires that shock loading not exceed 10 g's acceleration for 50 milliseconds.

	Yes	No
Test Successful	_____	_____

Test Engineer: _____

WITNESSES:

	Name	Organization	Title
1.			
2.			
3.			
4.			
5.			

SEE APPENDIX D & E

APPENDIX C

SPACE CORP. DOCUMENT 2101-T2

"TEST DROP PROCEDURE AND RESULTS
FOR
MODIFIED RECORDER CAPSULE P/N 2101-200"

TEST DROP PROCEDURE

AND

RESULTS

FOR

MODIFIED RECORDER CAPSULE

P/N 2101-200

DOCUMENT: 2101-T2

PREPARED BY: SPACE CORP.
DALLAS, TEXAS

SPACE CORP. JOB NO: 2101

NASA CONTRACT: NAS8-11819

TABLE OF CONTENTS

TEST DROP PROCEDURES AND RESULTS FOR MODIFIED RECORDER CAPSULE

I. PURPOSE OF TEST

This test is to be performed to assure that modifications made to the Recorder Capsules as specified in Contract NAS8-11819 are adequate to prevent undue damage to the Capsule during descent and impact after ejection from a parent missile. This test is for the Modified Recorder Capsule dropped from an altitude to simulate only the time interval to be experienced by the Modified Recorder Capsule and impact results, based on data derived from previously performed Dummy Recorder Capsule Test; Document 2101-T1.

TEST DROP PROCEDURES AND RESULTS
FOR MODIFIED RECORDER CAPSULE

II. DROP SITE

The test drop will be performed at the unused emergency airfield at Caddo Mills, Texas.

TEST DROP PROCEDURES AND RESULTS
FOR MODIFIED RECORDER CAPSULE

III. NOTIFICATION TO FAA

Eight (8) hours advance notice must be given to the local FAA office of the test drop.

IV. TEST CONDITIONS - WEATHER

The test drop will not be made under adverse weather conditions that impair safety, vision or the performance of certain check functions. It is preferred that nearly ideal weather conditions exist for the test drop. Rainy or misty weather that impairs visibility, safety, and photographic coverage are considered adverse conditions. Winds, steady or gusty, in excess of 10 mph are also considered adverse conditions; however, desirable wind conditions for drop up to 10 mph will be evaluated by the test engineer.

V. TEST PROCEDURE CHANGES

It will be the test engineer's responsibility and privilege to alter any part of the test procedure as required by immediate unforeseen problems or circumstances insofar as these deviations or changes do not detract from the overall intent of the test. It will also be his privilege and responsibility to stop or abort parts of the test or the total test if conditions are such that personnel and/or test item safety are in question.

TEST DROP PROCEDURES AND RESULTS
FOR MODIFIED RECORDER CAPSULE

VI. TEST EQUIPMENT

Helicopter

Binoculars

Stop Watch

Movie Camera

100 ft. Surveyor's Tape and Stakes

Machinist's Scale

Thermometer

Velometer

Arming Plug, P/N 596-9890

1 Pound Sack of Flour

Hand Tools

Large, Hard-Surface Clearing for Drop Site

Radio for Contact with Helicopter

VII. PERSONNEL REQUIRED

Helicopter Pilot

Helicopter Passenger

Vehicle Driver and Radio Operator

Cameraman

Observer (Binoculars)

Observer (Stop Watch)

TEST DROP PROCEDURES AND RESULTS
FOR MODIFIED RECORDER CAPSULE

VIII. TEST METHOD

Assemble the following equipment to be put aboard the helicopter:

a. Flour Sack (Marker)

b. Arming Plug (Red), 596-9890

c. Test Item (Dummy Recorder Capsule)

All other equipment shall be assembled at drop site.

Prior to boarding the helicopter, insert the Arming Plug, P/N 596-9890, into the Test Item to determine if there is any malfunction.

CAUTION:

DO NOT TURN POWER PACK SWITCH ON!

Remove the Arming Plug and mount Test Item into drop tube assembly on the helicopter. Place flour sack marker in helicopter.

Insert the Arming Plug into the Test Item.

CAUTION:

DO NOT TURN POWER PACK SWITCH ON!

TEST DROP PROCEDURES AND RESULTS
FOR MODIFIED RECORDER CAPSULE

Make certain the Test Item is clocked in the drop tube for access to the breakaway connector stirrup.

The helicopter will proceed to an altitude of approximately 5435 feet and hover at the up-wind edge of the drop site. The cameraman will be approximately 800 feet downwind from the expected drop area of the flour sack. When it is determined that the ground crew is ready, the helicopter shall remain as close as possible to the correct altitude and preparation for the drop will be made. The flour sack will be dropped and within approximately two (2) seconds, the toggle switch at the Power Pack (on board helicopter) will be actuated to "ON", the breakaway connector removed, and the Test Item dropped. The actual instant of drop will be conveyed to the ground and the stop watch will be started. The drop altitude will be relayed and recorded. At the instant of parachute deployment, the time will be recorded, as also will be the moment of impact with the ground.

The cameraman will take pictures of the parachute descent (to evaluate the oscillation characteristics), the impact, and

other photographs after impact as required to evaluate any damage that may have occurred and to record the actual impact surface.

After impact, a measurement to the nearest foot and in approximately a straight line, will be made from the point of impact of the flour sack to the point of the test item and recorded.

The binoculars will be used to observe all phases of the drop and information from this source will be entered in "comments" on the Data Sheet.

All above data will be recorded on Data Sheets No. 1 and No. 2

TEST DROP PROCEDURES AND RESULTS
FOR MODIFIED RECORDER CAPSULE

IX. DATA AND TEST EVALUATION

SEE APPENDIX F

TEST PROCEDURE 2101-T2

DATA SHEET NO. 1

DATE: _____

TIME: _____

Surface Wind (MPH) . . . . . F

Barometric Pressure (In. Hg.) . . . . . _____

Temperature (^{o}F) . . . . . _____

Drop Height (Helicopter Altitude) . . . . . _____

Time from Drop to Deployment (sec.) . . . . . _____

Time from Drop to Impact (sec.) . . . . . _____

Distance from flour marker impact to Test Item impact (feet) . . . . . _____

SEE APPENDIX

COMMENTS: _____

_____

Test Engineer _____

TEST PROCEDURE 2101-T2

DATA SHEET NO. 1
(Page 2)

Data Evaluation:

Successful completion of the test requires that deployment be successful and that drift, under wind conditions in Appendix "A" of the contract, shall not exceed 1000 feet.

If the measured distance of drift is in excess of 1000 feet, this shall be corrected by use of the Chart of Appendix "A" of the contract, the time of deployed descent, and with the surface wind as a constant for this time.

If this correction is required, the calculations shall be appended to this sheet and noted below:

		Yes	No
A.	Deployment Successful	_____	_____
B.	Drift Less Than 1000 Feet	_____	_____
C.	Drift Calculations Included	_____	_____

WITNESSES:

	Name	Organization	Title
1.			
2.			
3.			
4.			
5.			

APPENDIX D

DATA SHEETS NO. 1 AND NO. 2

FROM

TEST PROCEDURE DOCUMENT 2101-T1
(DUMMY CAPSULE TEST DROP #1)

DUMMY CAPSULE TEST # 1

(APPENDIX D)

TEST PROCEDURE 2101-T1

DATA SHEET NO. 1

DATE: November 30, 1965

TIME: A. M.

Surface Wind (MPH)	2-1/2 to 8 MPH
Barometric Pressure (In. Hg.)	30.33
Temperature (^{o}F)	55.5
Drop Height (Helicopter Altitude)	5400
Time from Drop to Deployment (sec.)	----------
Time from Drop to Impact (sec.)	51.3
Distance from flour marker impact to Test Item impact (feet)	----------

NOTE: Wind @ 1000 Ft. = 20 knots from 105^{o}
Wind @ 3000 Ft. = 25 knots from 120^{o}

COMMENTS: Capsule impacted ground at terminal velocity where parachute cover failed to be ejected. Test discontinued.

Test Engineer C. M. Xeros
C. M. Xeros

TEST PROCEDURE 2101-T1

DATA SHEET NO. 1
(Page 2)

Data Evaluation:

Successful completion of the test requires that deployment be successful and that drift, under wind conditions in Appendix "A" of the contract, shall not exceed 1000 feet.

If the measured distance of drift is in excess of 1000 feet, this shall be corrected by use of the Chart of Appendix "A" of the contract, the time of deployed descent, and with the surface wind as a constant for this time.

If this correction is required, the calculations shall be appended to this sheet and noted below:

		Yes	No
A.	Deployment Successful		No
B.	Drift Less Than 1000 Feet	N/A	N/A
C.	Drift Calculations Included	N/A	N/A

WITNESSES:

	Name	Organization	Title
1.	C. M. Xeros	SPACE Corp.	Sr. Project Engineer
2.	J. Turrentine	SPACE Corp.	Pilot
3.	O. P. Albright	SPACE Corp.	Project Engineer
4.	D. Worsham	SPACE Corp.	Project Engineer
5.	L. Costiloe	SPACE Corp.	Technical Representative
6.	D. Dugdale	SPACE Corp.	Photographer
7.	L. Horvath	SPACE Corp.	Manufacturer's Rep.
8.	B. Cline	IBM/NASA	
9.	Leo Arsement	NASA	

TEST PROCEDURE 2101-T1

DATA SHEET NO. 2

IMPACT LOADING:

Remove the strip chart from the impact recording instrument and record the following information:

1. Maximum Stylus deflection

	Chart Lines (To the nearest 1/2 line)
X	N/A
Y	N/A
Z	N/A

2. Convert the "chart Lines" to equivalent g's by use of Impact-O-Graph Calibration Tables B and C as applicable.

Stylus	Maximum "g's"
X	N/A
Y	N/A
Z	N/A

3. Determine horizontal distance that X Sytlus was equal to or above 10 g's value in 32nd of an inch.

Distance (equal to or above 10 g) for X stylus	32nd inch. N/A

TEST PROCEDURE 2101-T1

DATA SHEET NO. 2
(Page 2)

4. Convert distance to time by use of SPACE Corp.

Chart SK 2101-4

Time equal to or above 10 g's — Milliseconds: N/A

Test Engineer: _____

Date: _____

Data Evaluation:

Successful completion of this portion of the test requires that shock loading not exceed 10 g's acceleration for 50 milliseconds.

	Yes	No
Test Successful	n/a	N/A

Test Engineer: _____

WITNESSES:

	Name	Organization	Title
1.	N/A		
2.			
3.			
4.			
5.			

APPENDIX E

DATA SHEETS NO. 1 AND NO. 2

FROM

TEST PROCEDURE DOCUMENT 2101-T1
(DUMMY CAPSULE TEST DROP #2)

DUMMY CAPSULE TEST # 2

(APPENDIX E)

TEST PROCEDURE 2101-T1

DATA SHEET NO. 1

DATE: December 3, 1965

TIME: 1:40 p.m. to 3:30 p.m.

Surface Wind (MPH)	6-1/4 MPH
Barometric Pressure (In. Hg.)	30.21
Temperature (^{o}F)	54.0
Drop Height (Helicopter Altitude)	4200
Time from Drop to Deployment (sec.)	8.6 Seconds
Time from Drop to Impact (sec.)	2 Min. - 34 Seconds
Distance from flour marker impact to Test Item impact (feet)	2853 Feet

Note: Wind @ 1000 Ft. = 20 knots from 330^{o}
Wind @ 2000 Ft. = 20 knots from 015^{o}
Wind @ 3000 Ft. = 20 knots from 015^{o}
Wind @ 4000 Ft. = 20 knots from 015^{o}

COMMENTS: Good deployment, good impact, drift due to prevailing wind profile in excess of spec. but not unacceptable considering deployment appeared higher than 2000 feet planned. Recovered capsule in excellent condition.

Test Engineer C. M. Xeros
C. M. Xeros

Post Comment: 5 lb. flour sack drop from 4200 feet had a total free fall drop time of 29.5 seconds.

TEST PROCEDURE 2101-T1

DATA SHEET NO. 1
(Page 2)

Data Evaluation:

Successful completion of the test requires that deployment be successful and that drift, under wind conditions in Appendix "A" of the contract, shall not exceed 1000 feet.

If the measured distance of drift is in excess of 1000 feet, this shall be corrected by use of the Chart of Appendix "A" of the contract, the time of deployed descent, and with the surface wind as a constant for this time.

If this correction is required, the calculations shall be appended to this sheet and noted below:

		Yes	No
A.	Deployment Successful	Yes	
B.	Drift Less Than 1000 Feet		No. (see comments)
C.	Drift Calculations Included		No

WITNESSES:

	Name	Organization	Title
1.	C. M. Xeros	SPACE Corp.	Sr. Project Engineer
2.	J. Turrentine	SPACE Corp.	Pilot
3.	O. P. Albright	SPACE Corp.	Project Engineer
4.	D. Worsham	SPACE Corp.	Project Engineer
5.	D. Dugdale	SPACE Corp.	Photographer
6.	L. Horvath	SPACE Corp.	Manufacturer Rep.
7.	B. Cline	IBM/NASA	
8.	Leo Arsement	NASA	

TEST PROCEDURE 2101-T1

DATA SHEET NO. 2

IMPACT LOADING:

Remove the strip chart from the impact recording instrument and record the following information:

1. Maximum Stylus deflection

	Chart Lines (To the nearest 1/2 line)
X	3.0
Y	2.0
Z	1.5

2. Convert the "chart Lines" to equivalent g's by use of Impact-O-Graph Calibration Tables B and C as applicable.

Stylus	Maximum "g's"
X	8.2
Y	5.5
Z	4.1

3. Determine horizontal distance that X Sytlus was equal to or above 10 g's value in 32nd of an inch.

Distance (equal to or above 10 g) for X stylus: N/A 32nd inch. Did Not Exceed 10 g's

TEST PROCEDURE 2101-T1

DATA SHEET NO. 2
(Page 2)

4. Convert distance to time by use of SPACE Corp.

Chart SK 2101-4

	Milliseconds
Time equal to or above 10 g's	N/A

Test Engineer: C. M. Xeros

Date: 12-4-65

Data Evaluation:

Successful completion of this portion of the test requires that shock loading not exceed 10 g's acceleration for 50 milliseconds.

	Yes	No
Test Successful	yes	

Test Engineer: C. M. Xeros

WITNESSES:

	Name	Organization	Title
1.	C. M. Xeros	SPACE Corp.	Sr. Project Engineer
2.	J. Turrentine	SPACE Corp.	Pilot
3.	O. P. Albright	SPACE Corp.	Project Engineer
4.	D. Worsham	SPACE Corp.	Project Engineer
5.	D. Dugdale	SPACE Corp.	Photographer
6.	L. Horvath	SPACE Corp.	Manufacturer's Rep.
7.	B. Cline	IBM/NASA	
8.	Leo Arsement	NASA	

APPENDIX F

DATA SHEET NO. 1

FROM

TEST PROCEDURE DOCUMENT 2101-T2
(MODIFIED CAPSULE)

MODIFIED CAPSULE TEST # 1

(APPENDIX F)

TEST PROCEDURE 2101-T2

DATA SHEET NO. 1

DATE: December 3, 1965

TIME: 4:00 P.M. to 5:00 P.M.

Surface Wind (MPH)	6 mph
Barometric Pressure (In. Hg.)	30.21
Temperature (^{o}F)	54
Drop Height (Helicopter Altitude)	4200
Time from Drop to Deployment (sec.)	Estimated at 8 Seconds
Time from Drop to Impact (sec.)	3 Minutes, 13 Seconds
Distance from flour marker impact to Test Item impact (feet)	4220 Feet

Wind velocities were considered to be same as for Dummy Capsule Test # 2.

COMMENTS: Good deployment, better impact than with dummy capsule. Deployment appeared early and at high altitude other than 2000 feet planned. Recovered capsule in excellent condition.

Test Engineer C. M. Xeros

C. M. Xeros

TEST PROCEDURE 2101-T2

DATA SHEET NO. 1
(Page 2)

Data Evaluation:

Successful completion of the test requires that deployment be successful and that drift, under wind conditions in Appendix "A" of the contract, shall not exceed 1000 feet.

If the measured distance of drift is in excess of 1000 feet, this shall be corrected by use of the Chart of Appendix "A" of the contract, the time of deployed descent, and with the surface wind as a constant for this time.

If this correction is required, the calculations shall be appended to this sheet and noted below:

		Yes	No
A.	Deployment Successful	yes	
B.	Drift Less Than 1000 Feet		no (see comments)
C.	Drift Calculations Included		no

WITNESSES:

	Name	Organization	Title
1.	C. M. Xeros	SPACE Corp.	Sr. Project Engineer
2.	J. Turrentine	SPACECorp.	Pilot
3.	O. P. Albright	SPACE Corp.	Project Engineer
4.	D. Worsham	SPACE Corp.	Project Engineer
5.	L. Costiloe	SPACE Corp.	Technical Representative
6.	D. Dugdale	SPACE Corp.	Photographer
7.	L. Horvath	SPACE Corp.	Manufacturer's Rep.
8.	B. Cline	IBM/NASA	
9.	Leo Arsement	NASA	

APPENDIX G

IMPACT RECORDER TESTS
FOR
STYLUS MOTOR VOLTAGE PROFILE

AS RESULT OF
3 OHM RESISTOR BURNOUT
CAUSED BY
BRIDGEWIRE SHORT AT SQUIB END ON TIME DELAY RELAY

FINAL REPORT NO. 8 (FEBRUARY 7, 1966)
SPACE CORP. JOB 2101
NASA CONTRACT NAS 8-11819

PURPOSE OF TEST.

Detailed evaluation of the strip chart from the Impact Recorder on the Dummy Capsule on Saturday, December 4, 1965 (drop test date was December 3) revealed that the elapsed time derived from the chart speed (3 inches per second) from "parachute deployment" to "impact" did not reasonably agree with the "observed" stop watch time. Elapsed time by actual strip chart speed was 72 seconds, whereas observed elapsed time was 145 seconds. Since such a discrepancy in this elapsed time apparently occurred, it was considered mandatory to determine the cause.

Initial investigation of the electrical circuitry in the Dummy Capsule revealed a "burned" 3 OHM resistor on the component board assembly, see Figure 36. Referring to Figure 8, this resistor is ahead of the "match" or "squib" end of the pyrotechnic time delay relay in exactly the same manner as in the actual unmodified capsule (see Figure 35). Since this 3 OHM resistor is in the "on board" 24 V DC battery package circuit, a shorting in this circuit obviously caused failure of the resistor. It was determined that the bridgewires within the "match" or "squib" end of the pyrotechnic time delay relay had not burned apart when initiated by the 24 V DC battery power supply. This shorting constituted a dead short in this circuit causing a high momentary drain on the battery power supply which also drives the Impact Recorder chart drive motor (6 V DC). Until the 3 OHM resistor completely failed electrically (thereby removing the dead short), the speed of this drive motor was affected. It was deemed necessary to determine to what degree the drive motor (chart) speed was affected.

Without disturbing any part of the Dummy Capsule circuitry, a new 3 OHM resistor of identical manufacture (Ohmite #69V-3W) replaced the original on the circuit board, utilizing the same 24 V DC battery power supply used in the Dummy Capsule for Test Drop #2 of December 3, 1965. Since it was verified that the pyrotechnic time delay relay squib end was still shorted, actual drop conditions were considered to be existing for this test. Results of these tests are shown as Tests #1, #2, and #3. It can be concluded that with a fresh battery power supply such as existed for the test, that except for a very short interval of time, the time base shown at impact was unaffected by the 3 OHM resistor failure.

Following these tests at SPACE Corp. the pyrotechnic time delay relay with the shorted squib end was returned to the vendor for evaluation. Evaluation was also requested regarding "apparent" short firing time; less than 15 seconds plus or minus 20%. Atlas Chemical Industries letter of December 16, 1965 with accompanying test report and letter of February 9, 1966 are included in this report as favorable evidence that the relays operated correctly with the exception of the squib end shorting which was indicated to SPACE Corp. to be possible as occurred but would be a rare repetition. It should be noted that because of the sequence function of the 3 OHM resistor in the actual Modified Capsule, any shorting of the squib end of the time delay relay would have no affect on any part of the circuitry so as to cause a malfunction. In the actual Modified Capsule upon ejection from a vehicle, the circuit experiences only a momentary "starter" electric signal to this circuit and not a prolonged signal or voltage required by the Dummy Capsule impact recorder drive motor. Other than its affect on the Dummy Capsule drop test for this one case, the actual Modified Capsule is totally unaffected.

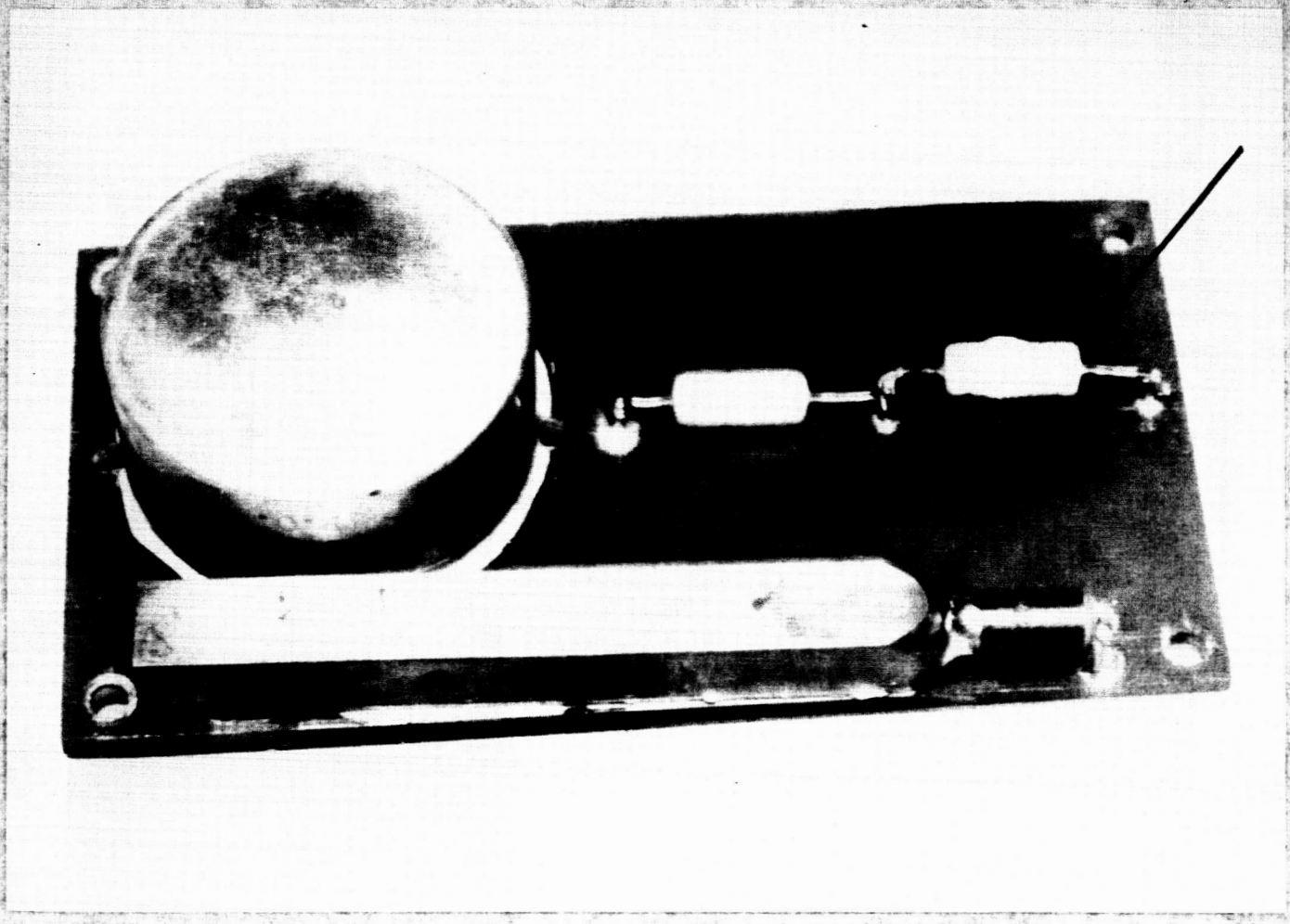


FIGURE 36

DUMMY RECORDER CAPSULE ASSEMBLY COMPONENT BOARD

TEST #1

STYLUS MOTOR VOLTAGE PROFILE

AS RESULT OF
3 OHM RESISTOR BURNOUT
CAUSED BY
BRIDGEWIRE SHORT AT SQUIB END ON TIME DELAY RELAY

DATE:	December 14, 1965, PM
TEST ITEM:	Dummy Capsule Circuit Board
PERFORMED BY:	C. M. Xeros - SPACE Corp.
	E. Elkins - SPACE Corp.
	O. P. Albright - SPACE Corp.
RESISTOR P/N:	Ohmite No. RW 69V-3W (3 OHM)
BATTERY VOLTAGE BEFORE START:	6.0 Volts

ELAPSED TIME (SECS)	VOLTAGE
Start	3.2
15	2.8
23 Burnout of 3 OHM Resistor	2.8/4.8
30	5.2
45	5.4
60	5.5
75	5.5
90	5.5
105	5.5
120	5.5
135	5.5
150	5.5
154 (2 Min., 34 Secs)	5.5

BATTERY VOLTAGE AFTER TEST: 5.9 Volts

Immediately following the above test, the stylus motor chart was run for 30 seconds as a time base check. At 5.9 volts the actual chart speed as measured on the chart was 86 inches. Theoretical speed is 90 inches for this 30 seconds.

$$\frac{86}{90} = .9555 \text{ of rated chart speed}$$

Then:

$$.9555 \times 3 \text{ inch/sec.} = 2.866 \text{ in./sec.}$$

Chart length check for 2 minutes, 34 seconds was made following above.

For 154 seconds length should be:

$$154 \times 3 \text{ in./sec.} = 462 \text{ inches}$$

Actual length is: 416 inches

Difference = 46 inches in 462 inches or 10% average.

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SPACE CORP. JOB 2101
NASA CONTRACT NAS 8-11819

TEST #2

STYLUS MOTOR VOLTAGE PROFILE

AS RESULT OF
3 OHM RESISTOR BURNOUT
CAUSED BY
BRIDGEWIRE SHORT AT SQUIB END ON TIME DELAY RELAY

DATE:	December 14, 1965, PM
	NOTE: This Test #2 was performed within 10 minutes of the conclusion of Test #1.
TEST ITEM:	Dummy Capsule Circuit Board
PERFORMED BY:	C. M. Xeros - SPACE Corp.
	E. Elkins - SPACE Corp.
	O. P. Albright - SPACE Corp.
RESISTOR P/N:	Ohmite No. RW 69V-3W (3 OHM)
BATTERY VOLTAGE BEFORE START:	6.0 Volts

ELAPSED TIME (SECS)		VOLTAGE
Start		3.5
15		2.9
30		2.75
45		2.65
48	Burnout of 3 OHM Resistor	2.60/4.6
60		5.0
75		5.1
90		5.2
105		5.2
120		5.25
135		5.25
150		5.25
154	(2 Min., 34 Secs)	5.25

BATTERY VOLTAGE AFTER TEST: 5.7 Volts

Immediately following above test, the stylus motor chart was run for 15 seconds as a time base check. At 5.7 volts the actual chart speed as measured on the chart was 42.5 inches. Theoretical speed is 45 inches for this 15 seconds.

$$\frac{42.5}{45.0} = .9444 \text{ of rated chart speed}$$

Then:

$$.9444 \times 3 \text{ inch/sec.} = 2.833 \text{ in./sec.}$$

No chart length check was made versus elapsed time.

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TEST #3

RESISTOR BURNOUT TIME ONLY
(NO CHART READINGS)

DATE:	December 14, 1965, PM NOTE: This Test #3 was performed within 10 minutes of the conclusion of Test #2.
TEST ITEM:	Dummy Capsule Circuit Board
PERFORMED BY:	C. M. Xeros - SPACE Corp. E. Elkins - SPACE Corp.
RESISTOR P/N:	Ohmite N . RW 69V-3W (3 OHM)
BATTERY VOLTAGE BEFORE START:	5.85 Volts
BATTERY VOLTAGE AT END:	5.40 Volts
ELAPSED TIME TO BURNOUT:	1 Minute, 11 Seconds
BATTERY CURRENT BEFORE START:	3.4 amps
BATTERY CURRENT AT END:	3.0 amps

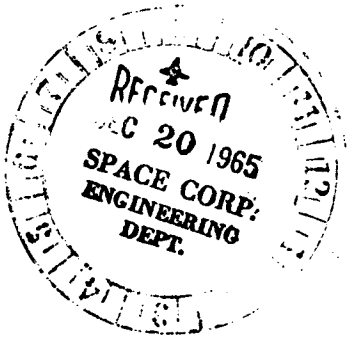
This concluded the tests.

ATLAS CHEMICAL INDUSTRIES, INC.

AEROSPACE COMPONENTS DIVISION

VALLEY FORGE INDUSTRIAL PARK
VALLEY FORGE, PA 19481

December 16, 1965



Space Corporation
P. O. Box 5175
Dallas, Texas 75222

Attention: Mr. C. M. Xeros

Gentlemen:

Please find enclosed a copy of the test results in regard to your Purchase Order No. S-48218.

If you require any additional information, please feel free to contact us.

Very truly yours,

ATLAS CHEMICAL INDUSTRIES, INC.

William J. Cardie
Sales Representative

WJC/sjk

Enc. 1

ORIGINAL

ORIGINAL

Switch Type MS 21-150 WRF
Purchaser S-48218
Spec. SPACE CORP

Lot Size 15
Sample Size 5
Lot No. HAP 95

Equipment:
Functioning 12x328-3
Counter Functioning C8
Trans.

Date 4/30/65 - 10/4/65
Atlas Order 4682 1C2
Tester D Mussa

Electrical
Test Set DDTS 30-2
Micro Volter VTVM1
Head MEGOHMMEIER MO-2

		−65° F					+160° F				
BEFORE @ AMB	Number	7	2	12			14	15			
	Bridge	1.08	1.1	1.08			1.12	1.15			
	Cir. 1 OC	X	X	X			X	X			
	Cir. 2 OC	2.7	2.6	2.7			3.0	2.5			
	Cir. 3 OC										
	Cir. 4 OC										
	Cir. 1A to all	X	X	X			X	X			
	1B	X	X	X			X	X			
	2A	X	X	X			X	X			
	2B										
	3A										
	3B										
	4A										
	4B										
	Case to all	5	40	X			X	140			
	Leads to all	5	300	X			X	X			
FUNCTION	1Amp 5MIN @ No Fire TEMP		OK	OK			OK	OK			
	4.5 Amp Fire 10 MilliSec PULSE	AVG	16.943				AVG	14.560			
	Func. Time SEC	16.857	17096	16876			14.626	14.493			
	Trans. Time										
AFTER @ AMB	Cir. 1	2.4	2.3	2.3			3.1	3.5			
	2	X	X	X			X	X			
	3										
	4										
	Cir. 1A to all	X	X	X			X	X			
	1B	X	X	X			X	X			
	2A	X	X	X			X	X			
	2B										
	3A										
	3B										
	4A										
	4B										
	Case										
	Case to leads @										
	Lead to lead @										

1. All means other test points shorted together.
2. Closed contact resistance in millohms.
3. Open contact resistance and insulation in megohms at 500 V or X = than 1000 megohms.

ATL 3220

ATLAS CHEMICAL INDUSTRIES, INC.

AEROSPACE COMPONENTS DIVISION

VALLEY FORGE INDUSTRIAL PARK
VALLEY FORGE, PA. 19481

February 9, 1966

Space Corporation
P. O. Box 5175
Dallas, Texas 75222

Attention: Mr. Ken Gracy, Buyer

Gentlemen:

Subject: Atlas Switch MS2.1-15.0-WRRF

Reference: Purchase Order No. 48856

Recently you returned one of the switches from your referenced purchase order which had fired within 9 seconds in lieu of 15 seconds.

The switch has been analyzed by our Design and Development Group for the possible cause of malfunctioning as follows:

1. The switch was x-rayed; the X rays showed nothing that would indicate it being other than acceptable.

2. The switch was then cut open--and when the burned delay column was examined by cross sectioning, it looked normal.

3. In our opinion, the most likely way that the delay time could have been shortened would have been for pressure to build up in the expansion chamber leaking around the press fit on the bottom of the delay in the switch housing and by-passing the cup containing the explosive charge; however, because of the press fit between cup and ferrule, this is an unlikely assumption.

ORIGINAL

4. To determine if a scratch in the press fit area could present a path, we filed a fairly deep groove in the press fit area on two switches; both functioned in 15 seconds indicating that even a known leakage could not accelerate the delay time.

It is our conclusion that since we were unable to duplicate the accelerated delay time, this particular switch received sufficient firing current 6 seconds prior to the recording of the delay firing. Whether this current was caused by a stray current or an extremely large amount of RF energy, we have no way of knowing.

We hope that you agree with our conclusion in regard to this matter.

Very truly yours,

ATLAS CHEMICAL INDUSTRIES, INC.
Aerospace Components Division

William J. Cardie
Sales Representative

WJC/sjk

ORIGINAL

APPENDIX H

16 MM MOVIE FILM (REEL A)

OF
DUMMY CAPSULE DROP TESTS #1 AND #2
AND
MODIFIED CAPSULE TEST
(SEQUENCE)

FINAL REPORT NO. 8 (FEBRUARY 7, 1966)
SPACE CORP. JOB 2101
NASA CONTRACT NAS 8-11819

This Reel A Movie is a chronological sequence of tests for the Dummy Capsule Test #1 (unsuccessful) and Test #2 (successful). The film also includes the successful Modified Recorder Capsule Drop Test. The film has been edited only to the extent that irrelevant and/or useless frames have been omitted.

APPENDIX J

16 MM MOVIE FILM (REEL B)

GENERAL - EDITED DROP TESTS
(NOT BY SEQUENCE)

FINAL REPORT NO. 8 (FEBRUARY 7, 1966)
SPACE CORP. JOB 2101
NASA CONTRACT NAS 8-11819

This Reel B is an edited version of the drop tests for the Dummy and Modified Capsules, not necessarily in chronological sequence related to the actual drop tests. This Reel B is included as part of this report primarily for the clarity and quality of certain events as compared to Reel A.